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# USSR Report

ELECTRONICS AND ELECTRICAL ENGINEERING

No. 77



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17 February 1981

USSR REPORT  
ELECTRONICS AND ELECTRICAL ENGINEERING

No. 77

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## AMPLIFIERS

UDC 621.374

### POWERFUL WIDE-BAND PULSE AMPLIFIERS USING METAL-INSULATOR-SEMICONDUCTOR TRANSISTORS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 96-98 manuscript received 3 Apr 79

D'YAKONOV, V. P., Smolensk Affiliate, Moscow Power Engineering Institute

[Abstract] The author describes wide-band pulse amplifier circuits based on a new class of semiconductor device--MIS microwave power transistors. Use of these devices considerably simplifies the amplifier circuit and improves parameters. Among the advantages of the new devices over bipolar transistors are: high linearity of the transfer characteristic (dependence of drain current on gate voltage), high input impedance, high maximum drain current, low capacitances, absence of phenomena of thermal and secondary breakdowns, high maximum voltage across the drain and low sensitivity to overloads. The proposed amplifier circuits have a settling time of less than 1 ns with operation on a resistive load, and 4-7 ns with operation on a capacitive load (20 pF). Output voltages are up to 40-50 V and currents are up to 1-2 A. Figures 2; references: 4 Russian.

[62-6610]

UDC 621.375.121

### A COMPOUND-CONNECTED OPERATIONAL AMPLIFIER BASED ON A K140UD8 MICROCIRCUIT

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 120-121 manuscript received 22 Nov 78

IVANOV, V. V. and MARCHENKOV, V. V., Leningrad Institute of Nuclear Physics, USSR Academy of Sciences

[Abstract] Compound-connected operational amplifier circuits are described for use in a voltage inverter and a noninverting voltage repeater. The proposed devices use a K140UD8 chip in the low-frequency channel in which a balancing variable resistor sets the zero bias voltage in a range of  $\pm 0.5$  mV at a temperature coefficient of 15

$\mu\text{V}/^\circ\text{C}$ . The rf channel is based on discrete bipolar transistors. The low-frequency gain is  $\pm 10^6$ , and the weak-signal unit-gain bandwidth is 160 MHz. The unit-gain amplifier rise time at an output voltage of 5 V is  $\pm 2.5$  ns. Frequency response can be improved by using a Teflon circuit board. Figures 3; references 5: 4 Russian, 1 Western.  
[62-6610]

## ANTENNAS

UDC 621.396.67.01

### TO THE CALCULATION OF UNAXISYMMETRICAL REFLECTORS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1817-1822  
manuscript received 8 Dec 78

POVOLOTSKIY, F. K. and SIDOROVA, T. P.

[Abstract] The geometry of the problem is shown. From a point  $O$  a pencil of rays issues with a distribution of amplitudes unaxisymmetrical relative to the axis  $Z$ , and has some plane  $\theta$ , the normal to which forms an arbitrary angle with axis  $Z$ . It is necessary to find such a surface, after reflection from which the beam crossing the plane  $\theta$  will leave a trace in the form of a circle of radius  $R$  with a distribution of amplitudes on it, symmetrical relative to the center of this circle with a random distribution of phase. The surface of the reflector  $Z(x,y)$  is sought by the method of geometrical optics according to the known parameters of the pencil of rays incident and reflected from the mirror. For a solution of the problem in hand a system of coordinates is chosen so that the plane  $ZOY$  passes through the center of illumination of the circle. The problem is solved for an irradiator with an unaxisymmetrical beam pattern. The authors express their thanks to V. A. Kaloshin for a number of helpful comments. Figures 2; references: 2 Russian.  
[68-6415]

UDC 621.396.67.01

### RADIATION PATTERN OF A VARIABLE PROFILE ANTENNA

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1829-1843  
manuscript received 23 Nov 79

ABRAMOV, I. B., BAKHVALOV, N. S., BELKINA, M. G., ZHILEYKIN, Ya. M. and FEL'D, Ya. N.

[Abstract] An account is given of the methodology used and the results of calculations of the radiation pattern of a variable profile antenna of which the principal mirror consists of a large number of separate identical movable elements (panels) which are excited by one source. By varying the position and slope of the panels in two planes it is possible to change the form of the mirror as a whole, which in combination with the change of position of the source, can bring about movement of

the beam in an elevation plane. Rotation of the pattern with respect to azimuth is assured by movement of the operating sector of the panels, with corresponding rotation of the radiation pattern of the source. Calculation of the field in the distant region is conducted by means of a summation of fields which are produced by the separate panels, which in turn are calculated by the current method. This method gives reliable results in the region of the major, and a large number of side lobes. The results of the calculating formulas are given and the methods for calculation of the integrals received are presented. Figures 13; references: 4 Russian.

[68-6415]

UDC 621.396.67.01

#### ON THE ACCURACY OF RANGE ESTIMATION IN THE FRESNAL ZONE WITH A DISCONTINUOUS SOUNDING SIGNAL

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 2007-2009  
manuscript received 18 Apr 79

TRIFONOV, A. P. and FEDOROV, V. I.

[Abstract] The potential precision of estimates of the coordinates of a target situated in the Fresnal zone was considered in four previous papers coauthored by A. P. Trifonov, and in other reports. In so doing it was shown that in the Fresnal zone the accuracy of range estimation substantially increases, and the characteristic estimation of angular coordinates is approximately the same as with the situation in the far zone. The analysis of the accuracy of range estimation fulfilled in the above papers was accomplished on the basis of the Kremer-Pao formula, which is inapplicable in the case of the use of discontinuous sounding signals, i.e., signals with a step-wise change of the amplitude or phase modulation laws. The present short communication studies the case of such a discontinuous sounding signal as applied to a linear antenna with a length of  $2l$ . This signal is a spherical wave and is received on a background of additive space-time white noise with a one-sided spectral density  $N_0$  and an initial phase, random and distributed equally probably in the interval  $[0; 2\pi]$ . Figures 1; references: 10 Russian.

[68-6415]



## CONCERNING ONE ALGORITHM OF SIGNAL PROCESSING IN MULTIBEAM ANTENNA ARRAYS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1810-1816  
manuscript received 20 Aug 79

DANILEVSKIY, L. N., DOMANOV, Yu. A. and KOROJKO, O. V.

[Abstract] Solution of a number of problems of space-time signal processing is connected with the development of equipment which assures a simultaneous survey of some sector of space with the aid of a fan of static antenna radiation patterns (beams). The present paper mentions a number of shortcomings in such equipment and proposes an algorithm of signal processing in multibeam antenna arrays free from the above problems. With the aid of the proposed method it is possible to obtain a more effective suppression of the lobes of discrete phasing than is customary. Figures 6; references 5: 3 Russian, 2 Western (one in translation).  
[68-6415]

## SYNTHESIS OF THE FREQUENCY CHARACTERISTIC OF A PHASED ANTENNA ARRAY WITH OPTICAL IRRADIATION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1823-1828  
manuscript received 23 Oct 78

SEREBRENNIKOV, V. I. and SHTEKHMAN, G. Ya.

[Abstract] An expression is derived for the frequency characteristics of phased antenna arrays (PAA) with optical irradiation, with the assumption of continuous distribution of the phasing elements. It is also assumed that the structure of a PAA allows a change of the amplitude distribution (as, for example, in the case of an active PAA) and by means of a variation of it, it is possible to change the characteristics of the PAA within wide limits. Synthesis of amplitude distribution of the PAA assures the best, in a sense, approximation to the required frequency characteristics of the array. This problem is formulated as follows: find the amplitude distribution with respect to the aperture of the PAA which assures the best approximation of the frequency characteristics of the array to the arbitrary frequency characteristic of a linear filter in space with a quadratic metric. The problem is solved with the aid of a Fredholm equation. Figures 1; references 6: 4 Russian, 2 Western (1 in translation).  
[68-6415]



## EFFICIENCY OF ACTIVE ANTENNA SYSTEMS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1994-1996  
manuscript received 22 Jun 78

BUBNOV, G. G., SNEG, L. N., AZYUKIN, A. V. and OCHKOV, D. S.

[Abstract] The noise properties are analyzed of an antenna array consisting of symmetrical dipoles with high-resistance wide-band antenna (WBA) amplifiers connected to their terminals, and a diagram-forming circuit. Dipoles are considered with a length of 4 meters and a width of 0.08 meter, positioned at a distance of 2.5 meters from the screen. Calculation of the characteristics of the antenna array is conducted in the 10-30 MHz frequency range. Graphs of the dependence of the matching coefficient of an active dipole on the frequency, and the dependence of the noise temperature of the WBA (shown at the input of the diode) on frequency are presented. These graphs clearly illustrate the decrease of the contribution of the WBA to the resulting noise of the system with the arrangement of the active dipoles in a compact array. This effect appears particularly strongly in the low-frequency part of the range considered, when the period of the array in the H-plane is close to  $1/100$  of the effective length of the wave. During this the contribution of the WBA noise is decreased more than 10 times in comparison with antennas in free space. The sensitivity of such a system will be determined to a large extent by the exterior noise which in the range considered attains a magnitude on the order of  $10^5$ -- $10^8$ °K. Figures 3; references 5: 3 Russian, 2 Western (1 in translation).  
[68-6415]

## SOLUTION TO THE PROBLEM OF THE DIFFRACTION OF A PLANE WAVE IN A LINEAR ARRAY BY MEANS OF THE METHOD OF AUXILIARY SOURCES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Sep 80 pp 1607-1613  
manuscript received 9 Apr 79

MALAKSHINOV, N. P., YERIKHOV, V. G. and YAKIMOV, I. L.

[Abstract] Coupling can distort the directivity diagram of antenna arrays and under certain conditions result in its breakdown. Here a numerical method is suggested for solving the problem of the diffraction of a plane wave in a linear antenna array and for analyzing coupling in a finite array. The method discussed is the auxiliary sources method proposed by Malakshinov and Yerikhov (1977), which makes it possible to analyze the influence of coupling both on the directivity diagram and on the amplitude-phase distribution for arrays consisting of elements with various configurations. Two models are discussed which simulate arrays of the transfer type excited by a longitudinally polarized plane wave with a beam swinging angle of  $\theta_0$ . The

first model is a system of  $N$  ideally conducting infinitely long cylinders with radius  $a$  spaced at a distance of  $d$ , and the second is a system of  $N$  ideally conducting infinitely long infinitely thin strips with a width of  $l$  spaced at a distance of  $d$ . Directivity diagrams are calculated without taking coupling into account by the following equation:  $F_1(\theta) = f(\theta) \times M(\theta)$ , where  $f(\theta)$  is the directivity diagram of a single element in free space calculated by the method of auxiliary sources and  $M(\theta) = \sin [N(kd/2)(\cos \theta - \sin \theta_0)] / N \sin [(kd/2)(\cos \theta - \sin \theta_0)]$  is the array factor and the real directivity diagram is represented by  $F_2(\theta)$  by means of the method of auxiliary sources. The influence of coupling on directivity diagrams is evaluated by comparing functions  $F_1(\theta)$  and  $F_2(\theta)$ . The fields of auxiliary forces are taken into account in writing boundary conditions. A system of equations is derived which makes it possible to take into account the mutual influence of elements. Calculations were performed on an "M-222" computer. Graphs illustrating the influence of coupling on directivity diagrams for an array of cylinders and strips show that coupling influences the width of the main lobe, the level of fringe radiation and the beam scanning pattern. The influence of coupling is minimal over the range of  $\theta_0 \approx 0$  to 20 degrees and increases with a further increase in the scanning angle. Dependences of effects of coupling are of a general nature for arrays consisting of various elements but having an identical structure. Coupling distorts the amplitude-phase distribution. These distortions increase with an increase in  $\theta_0$ . Distortions are especially high with high  $N$ . Figures 5; references: 4 Russian. [44-8811]

UDC 538.574.6

#### SYNTHESIS OF A TWO-DIMENSIONAL REACTIVE REFLECTOR

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 59-63 manuscript received 15 Jun 79, after revision 27 Aug 79

PETROV, B. M. and YUKHANOV, Yu. V.

[Abstract] Approximate methods must be substituted for rigorous electrodynamic calculations in solving problems of synthesizing impedance reflectors of large electrical dimensions. In this paper, a physical optics technique is used to get an explicit expression for reactive impedance on the surface of a two-dimensional reflector with arbitrary cross section for producing a given scattering pattern. This impedance ensures that the backscattered field will be the same as that of some given ideally conductive reflector. The results agree well with experimental data. Figures 3; references: 6 Russian. [64-6610]

# **DIRECTIONAL CHARACTERISTICS OF AN ANNULAR SLOT WITH ASYMMETRIC EXCITATION ON A SPHERE WITH A DIELECTRIC LAYER**

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 85-87 manuscript received 28 May 79

SHUNIN, O. A.

[Abstract] An electrodynamic model in the form of a ball with a dielectric layer can be used to study the influence that a coating has on the directionality characteristics of skin antennas. The author considers asymmetric excitation of an annular slot on a sphere with a dielectric shell as a basis for analyzing axial emission of antennas. The method of eigen-functions is used with expressions for the coefficients of the primary field inside the dielectric shell in order to find the coefficients of excitation of fields of electric and magnetic waves in the external region and the electric field in the region where the angular field distribution is independent of distance. The radiation pattern is calculated on a YeS 1033 digital computer. The results show that the nature of radiation depends on the electrical radius of the annular slot. For short radii, the pattern is formed chiefly by the primary field of the slot, and the layer only causes a slight change in the width of the major lobe. The pattern is oriented toward the forward half-space for all thicknesses of the dielectric layer. For slots of large dimensions, emission is determined to a great degree by currents induced on the sphere, and when the layer is very thick, the radiation pattern is oriented toward the rear half-space. Figures 2; references 3: 1 Russian, 2 Western.  
[64-6610]

# **PROPAGATION OF ELECTROMAGNETIC WAVES IN CONICAL EQUAL-PITCH HELICAL ANTENNAS WITH SHORT AXIAL LENGTH**

Kiev IZV. VUZ: RADIOELEKTRONIKA In Russian Vol 23, No 9, Sep 80 pp 64-67 manuscript received 28 Mar 79, after revision 21 Jan 80

CHUZHKOV, Yu. P. and FILONENKO, V. A.

[Abstract] Experimental studies are done on the distribution of relative amplitudes and phases of the voltage on the conductors of conical equal-pitch single-helix antennas with large angle of taper and various parameters. A conical equal-pitch helical antenna is the projection of a spiral of Archimedes on a conical surface. Measurements were done on antennas with angles of taper of 30-60°, winding pitches of 6-26 mm, 7-15 turns and base diameters of 200-370 mm. Excitation was direct through a 75-ohm coaxial cable on the base side. Capacitive probes were used. It was found that the amplitude of the voltage wave reflected from the end of the helix increases

with the angle of taper. A load must be connected to the antenna in order to eliminate this effect. The phase velocity of propagation of an electromagnetic wave along the wires of helical antennas remains practically constant over the entire length of the helix. Figures 5; references: 2 Russian.  
[64-6610]

UDC 621.396.677

#### SYNTHESIS OF A HORN EXCITER THAT RADIATES A FLAT SURFACE WAVE

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 68-70 manuscript received 2 Jan 79

YEROKHIN, G. A., KOCHERZHEVSKIY, V. G. and GOIFMAN, V. G.

[Abstract] A solution is found for the problem of synthesizing a horn radiator fed by a flat sloping waveguide of arbitrary length. The upper wall of the horn is a continuation of the upper wall of the feeder waveguide, the termination being in the region where the field of the excited surface wave vanishes for practical purposes. The shape and distribution of the surface wave of the lower wall of the exciter are determined. The field in the horn is determined with consideration of "matching" to the field in the driver waveguide and transition without radiation into the field of the unperturbed surface wave at the exciter output. The width of the feeder waveguide is taken as less than half a wavelength. The proposed method of calculation was applied to synthesis of an exciter for a modulated surface wave antenna with unlobed natural radiation pattern. Experimental results show that the level of side lobes in the frequency band of 7500-10,000 MHz does not exceed -25 dB with corresponding efficiency of 93%. Figures 2; references: 4 Russian.  
[64-6610]

PROPERTIES OF AN ADAPTIVE ANTENNA ARRAY WITH CONTROLLABLE POLARIZATION IN THE  
PRESENCE OF A COMPLETELY POLARIZED INTERFERENCE GROUP

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 90-92 manuscript  
received 25 Jul 79

NGUYEN TAN DIN' and NGUYEN ZI LIN'

[Abstract] An analysis is made of the properties of adaptive antenna arrays in which provisions are made for control of the polarization properties as well as the polar pattern of the array. A linear array is considered in which each of the elements contains horizontally and vertically polarized radiators. Adaptation of the weighting factors maximizes the ratio of the signal to noise plus interference. An expression is derived for the vector of the weighting coefficients, from which the partial radiation patterns of the array can be determined in the vertical and horizontal planes. Such expressions are given reduced to the maximum value of the initial partial patterns in the respective plane. Graphs are plotted from the resultant formulas for an array in which the radiators of the elements are vertical and horizontal half-wave dipoles. Such an array can suppress interference even when the source is located in the major lobe of the radiation pattern. Figures 2; references 7: 4 Russian, 3 Western.

[64-6610]

AN INTEGRAL EQUATION METHOD FOR CALCULATING THE CHARACTERISTICS AND PARAMETERS OF A  
PLANAR LOGARITHMIC-SPIRAL ANTENNA

Kiev IZV. VUZ: RADIOELEKTRONIKA In Russian Vol 23, No 9, Sep 80 pp 53-58 manuscript  
received 28 Mar 79, after revision 27 Aug 79

MAL'TSEV, V. M. and TIMIREV, N. P. [deceased]

[Abstract] One of the methods for calculating the characteristics and parameters of antennas is based on using the current distribution found by solving the integral equation of a thin wire antenna of arbitrary shape. In this paper, such an equation is derived for the case of a logarithmic spiral antenna located above an infinite horizontal plane. Expressions are given for calculating the directivity characteristics of the antenna in integral form. Results of numerical calculations done on the Minsk-32 digital computer are given for current distribution, directivity characteristics and polarization parameters. The results agree satisfactorily with experimental data. Figures 4; references 7: 4 Russian, 3 Western.

[64-6610]



CERTAIN ASPECTS OF COMPUTER HARD AND SOFTWARE:  
CONTROL, AUTOMATION, TELEMECHANICS, TELEMETERING,  
MACHINE DESIGNING AND PLANNING

UDC 681.3.004(439)

USE OF MICROPROCESSORS IN THE CENTRAL INSTITUTE OF PHYSICAL RESEARCH OF THE  
HUNGARIAN ACADEMY OF SCIENCES

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 9, 1980 pp 12-14

ERENYI, I., Hungarian People's Republic

[Abstract] A brief review of the way that microprocessors are used in work at the Institute of Measurement and Computer Equipment, a division of the Central Institute of Physical Research (TsIFI) of the Hungarian Academy of Sciences. Also described are auxiliary facilities for design and alignment of the microprocessor systems developed at the Institute. Particular emphasis is given to research results that may be helpful to future large-scale integration (LSI) users. The use of microprocessors at the Institute had its inception with the development of a universal modular system of technical facilities based on LSI. The basis of the modular system is a multi-microprocessor dataway. From this start a system of programs has been developed for microprocessor modules using the TRA-1 minicomputer. The next step was development of a modular family of auxiliary designing and debugging facilities based on microcomputers. One application of this system has been the design of a color display system and pertinent software. The use of microprogrammable microprocessors is described. References: 4 Hungarian.

[82-6610]

# A SPECIAL-PURPOSE HYBRID COMPUTER FOR CALCULATING THE FOURIER COEFFICIENTS OF A SPECTRUM WITH A LOGARITHMIC FREQUENCY SCALE

Leningrad IZV. VUZ: PRIBOROSTROYENIYE in Russian Vol 23, No 9, Sep 80 pp 49-52  
manuscript received 21 Dec 79

GORELIK, V. I., RZHEUTSKAYA, S. Yu. and SVIN'IN, S. P.

[Abstract] A high-speed digital device is described which generates trigonometric functions on the basis of their piecewise-linear expansions, for the purpose of computing the Fourier coefficients of a frequency spectrum with a logarithmic scale covering third-octave bands. Digital codes proportional to the values of sines and cosines are produced in adders. In addition to the two adders, this device includes a Walsh-function generator, an octave counter with an octave number decoder, a time-selector switch with a control-pulse generator, three logic circuits, a memory, and two digital-to-analog converting multipliers for the two trigonometric functions. The paper was recommended by the Department (Kafedra) of Computer Engineering, Leningrad Electrical Engineering Institute imeni V. I. Ul'yanov. Figures 1; tables 1; references: 4 Russian.  
[71-2415]

# STATISTICAL SYNTHESIS OF LINEAR REGULATION SYSTEMS FROM THE DISPERSIONS OF DERIVATIVES OF THE DRIVING ACTION

Leningrad IZV. VUZ: PRIBOROSTROYENIYE in Russian Vol 23, No 9, Sep 80 pp 21-25  
manuscript received 29 Nov 79

NEBYLOV, A. V.

[Abstract] A statistical synthesis and optimization of a linear regulation system with a given open-loop transfer function is shown which involves the dispersions of only the first two derivatives of the driving action. A constraint on the closed-loop error response is established which will ensure that the dispersion of the dynamic regulation error does not exceed a prescribed limit. In a special case a relation is obtained for a system with an either unknown or infinitely large dispersion of the second derivative. When a random centered interference with a given density accompanies the driving signal, then the system can be optimized parametrically according to the criterion of a minimum sum of maximum permissible dispersion of the dynamic error and dispersion of the error due to the interference. The algorithm of this optimization is demonstrated on a simple specific numerical example. The paper was recommended by the Department (Kafedra) of Electron Devices in Control Systems, Leningrad Institute of Aircraft Instrument Building. Figures 2; references: 4 Russian.  
[71-2415]

## FILTRATION UNDER CONDITIONS OF NONSTATISTICALLY PREDETERMINED UNCERTAINTY

Kiev AVTOMATIKA in Russian No 2, Mar-Apr 80 pp 13-21 manuscript received 22 Jan 79

BAKAN, G. M., Institute of Cybernetics, UkSSR Academy of Sciences

[Abstract] A non-minimax approach is developed for solving problems of identification relative to interference for the class of multivalued processes with discrete time. The proposed method leads to results that are essentially analogous to the recurrent Bayes algorithm in the theory of statistical estimates, and is the optimum procedure for data processing under the conditions considered in the paper. The analysis is based on elements of set theory and conveniently accounts for uncertainty of a nonstatistical (or in general unknown) nature that shows up in a number of applied problems of filtration. The problem is treated as a job of finding a method to construct a set in the space of states of the evolving process (an a posteriori set) that necessarily contains the set that is to be estimated. The a priori set whose element is the unknown initial state of the process is taken as given, as is the set of observations perturbed by limited interference. A rule is defined for transforming the initial a priori set into the a posteriori set. Figure 1; references 7: 6 Russian, 1 Western(in translation). [65-6610]

## PROBLEMS OF DESIGNING A MULTIPURPOSE ERGATIC SYSTEM FOR PREVENTING SHIP COLLISIONS

Kiev AVTOMATIKA in Russian No 2, Mar-Apr 80 pp 52-59 manuscript received 16 Jul 79

PAVLOV, V. V., BARANOV, V. L. and POLOZHENTSOV, I. A., Institute of Cybernetics, UkSSR Academy of Sciences

[Abstract] Despite considerable improvements in the International Regulations for Preventing Collisions at Sea, there has been no abatement of this danger to shipping. This article suggests an approach to development of an automated system of preventing such collisions based on the principles of designing ergatic control systems. It is shown that efficient organization of a multipurpose ergatic system for preventing collisions of ocean-going vessels could increase shipping safety by reducing the number of erroneous decisions made by navigators. The proposed system has the capability of attaining any goal in a certain finite set, intensifying the functional activity of the human navigator, and maintaining its functional behavior constant within certain set limits (homeostasis). By optimum distribution of functions between the operator and the automatic equipment with consideration of the human element, the stress on the operator is relieved, thus reducing fatigue and



improving the reliability of the control loop as a whole. Technical-economic indices are improved by more efficient maneuvering due to inclusion of a unit that classifies the hazards of impending situations. References: 7 Russian. (65-6610)

UDC 621.396.6:658.562.011.56

#### TREND OF CREATING PROBLEM-ORIENTED SOFTWARE FOR AUTOMATED TESTING OF RADIO ELECTRONIC EQUIPMENT UNDER PRODUCTION CONDITIONS

Moscow IZMERENIYA KONTROL' AVTOMATIZATSIYA in Russian Nos 3-4, 1980 pp 42-47

YEFIMOV, A. N., doctor of technical sciences, BYSTROV, O. N. and KAMENSKOY, A. S., candidates of technical sciences, and KOCHAROV, R. A. and YUDOVSKIY, B. Z., engineers

[Abstract] The development of the automation of processes of testing and diagnosing radio electronic equipment has been characterized by a changeover from local testing automata to automated testing systems based on control computers and has resulted in the need to unify the software of these systems. This unification is especially important for the application of automated testing systems in the manufacturing process, because of the broad nomenclature of equipment and the similarity of testing operations performed. The basis for the unification of software is unification of its structure and of methods of making it problem oriented. Problem orientation of software which will make the use of this software effective is achieved by selecting a system of models appropriate for a specific class of test objects; this results in modification of an input language of the ATLAS type in the direction of saturating it with procedural description software. The ATLAS language is an example of a unified abbreviated testing language designed for preparing and describing testing procedures which can be implemented both manually and by means of automatic or semiautomatic testing equipment. A discussion is presented here of methods and principles of the unification of testing facilities and procedures. The problem of unifying automated testing systems involves isolating general problems relating to testing and structures for solving them and implementing these structures with selected computer software and hardware. It is emphasized that problem orientation results only in modification of the testing language, but that its basis remains as before. The key characteristics are presented for software structures of existing automated testing systems. Individual automated testing systems for radio electronic equipment, utilizing control computers, are discussed, including the Hughes FLT (Flight Line Tester) system, the Bendix automated testing and measuring complex, the DIF firm's use of the TERMINAL/10 module controlled by a PDP-11 computer, the use of the programmed system of automatic measuring equipment for radio telephone lines controlled by a Tektronix TEK 31 minicomputer, the use by Siemens of instruments and testing systems designed to automate all measuring and testing operations both for individual testing units and in large systems, and the PEGAMAT K1074 (FRG) automated system designed for testing circuit boards. Classes of test objects and how they are reflected in the structure of the software are discussed. A diagram

is given of levels of descriptions of the testing process and of automated testing system software. The organization of the data base and the types of data in automated testing system software are discussed. Figures 1; references 21: 6 Russian, 15 Western(1 in translation).  
[41-8831]

UDC 681.317

#### A MULTIFUNCTIONAL INFORMATION MEASUREMENT SYSTEM FOR ANALYZING STATISTICAL SIGNALS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul Aug 80 p 250 manuscript received 14 Feb 79

MALEVICH, I. A., POSTOYANOV, Yu. I., GUBSKIY, V. I., IVANOV, V. I., YEFREMENKO, D. A., D'YAKOV, V. A., USTINOV, B. P. and KONDRATYUK, V. V., Laboratory of Analog-Digital Measurement Methods, Scientific Research Institute of Applied Physics Problems Affiliated with Belorussian State University

[Abstract] A measurement information system is proposed for normalizing detected input streams of signals, analyzing statistical distributions of stochastic pulse streams of weak optical signals, measuring background intensity, precision multichannel time analysis of statistical sequences of pulse signals. Operation of the system is based on multichannel interpolation time analysis of stochastic intervals with leveling analog-dynamic memorization of the fields of phases of times of appearance of signals relative to a local time scale in the programmed space-time zone of analysis. Intensity of the input signal flow is  $1-5 \cdot 10^7$  Hz, dynamic range of analysis is  $2 \cdot 10^{-7}-10$  s, and maximum number of events that can be analyzed in a single cycle is 4. Measurement devices include a multichannel linear commutator, a multichannel device for matching scales and interpolation, a multichannel device for eliminating ambiguity of data storage, an adaptive analog-dynamic memory, a time scale selector, and a programmable gate aperture synthesizer. Translators and I/O devices provide interfacing with a wide class of minicomputers. The equipment measures  $1800 \times 520 \times 420$  mm and weighs 250 kg. Figures 1.  
[62-6610]

## AUTOMATION OF THE DESIGN OF PNEUMATIC LOGIC CIRCUITS

Moscow IZMERENIYA KONTROL' AVTOMATIZATSIYA in Russian Nos 3-4, 1980 pp 35-41

SOROKIN, V. A., engineer, and LANIN, N. D., candidate of technical sciences

[Abstract] The creation of a procedure for designing pneumatic logic circuits by means of a computer is discussed. At the design stage the problems are solved of the layout of the logic circuit--the distribution of basic elements such as relays and valves over modules, subblocks and blocks--the placement of basic elements or structural elements at the mounting positions of structural elements of the next level, and the routing of connections within the limits of each structural element, i.e., module, subblock or block. It is demonstrated that the traditional criterion for the quality of designs of logic circuits--the total length of connections--does not always result in improvement of the functional characteristics of a circuit. The geometrical parameters of some connections influence the technical characteristics of pneumatic logic circuits to a greater degree than do the parameters of other connections. It is emphasized that the speed of response of a circuit is determined only by the speed of response of those basic elements and connections which belong to the critical path. An analysis is made of the dynamics of a pneumatic logic circuit. A system of functions is presented for describing the dynamics of the process of signal transmission by means of pneumatic elements. A procedure is presented for calculating the maximum delay of a signal at the output of the circuit,  $T_{\max}$ , which determines its speed of response. This procedure consists in ranking the circuit's basic elements by assigning to each basic element a number or rank equal to the maximum number of basic elements in the path of the signal from the circuit's input to the basic element in question; reviewing basic elements in the order of an increase in rank, in the course of which to each  $k$ -th input of the  $j$ -th basic element are assigned the value of the maximum delay for the appearance of a signal at the point of the circuit in question from the instant of a change in the set of signals in the circuit's input and the characteristic of the slope of the signal's front at this point in the circuit; and reviewing basic elements in the order of a decrease in rank. In the course of the last step to each  $k$ -th input of the  $i$ -th basic element are assigned two values of the maximum delay from the moment of appearance of signals  $x = 0$  and  $x = 1$  at this point in the circuit to the moment of a corresponding change in signals in the outputs of the circuit, as well as the amount of the reserve in delay for the path of propagation of the signal through this point in the circuit,  $\Delta_{ik}$ . By analyzing the distribution of  $\Delta_{ik}$  it is possible to isolate the critical and subcritical path whose connections should be made shorter and to determine the possibility of shortening  $T_{\max}$ . A generalized criterion for the quality of the design of a pneumatic logic circuit is discussed. For this purpose weights are assigned to connections for each indicator, which take on a higher value, the greater the negative influence exerted by the connection in question on this indicator. Questions relating to selecting algorithms for solving typical problems in designing pneumatic logic circuits are discussed. For pneumatic logic circuits distinguished by considerable loss of speed of response in external connections, an intelligent layout dictates that the critical path for propagation of the signal pass through the lowest number of structural elements. Variants of

"dividing up" a logic circuit are discussed, along with the distribution of the elements of pneumatic logic circuits. The problem of the distribution of elements reduces to finding a set of elements,  $N$ , at a set of positions,  $P$ , on the basis of a matrix of distances between pairs of positions and of some criterion for the quality of distribution. The algorithm for solving this problem, however, can be realized only for a limited number of elements to be distributed. Therefore, approximation algorithms are employed, which include the stages of an initial distribution and optimization of this distribution by means of changing the positions of elements. The problem of routing communication channels in multilayer boards is discussed. An example is given of the communication layer of a board for mounting series PLMI integrated pneumatic modules. Figures 4; references 17: 14 Russian, 3 Western (1 in translation).

[41-8831]

#### EFFECT OF A TELPHER LINE

Moscow AVTOMATIKA, TELEMEXHANIKA I SVYAZ' in Russian No 8, 1980 pp 16-17

PANTSEVICH, V. K., chief, Bransk-L'gov Length of the Moscow Railroad

[Abstract] Instruments for electrical interlocking and automatic blocking systems for railways are delivered in containers from the check-and-test point to a platform for loading the containers onto a motor trolley, and back to the check-and-test point in the same manner. A description is given of a telpher line constructed for the purpose of mechanizing this process. The telpher line is 70 m long and leads from a roofed platform for containers at the doors of the check-and-test point to the loading platform beside the tracks. The type T-10432 telpher has a load-lifting capacity of 3.6 tons and it moves along a No 36 I-beam. This I-beam is fastened to cross beams by means of bolts 25 mm in diameter and the cross beams consist of two No 25 channel bars welded together along their walls and fastened to ferroconcrete pillars. The distance between pillars along the axis of the telpher line is 5.5 m and the distance between them breadthwise is 4.2 m. A contact wire used on electrified railroads serves as the current carrier. The wire is fastened to insulators used on trolley bus lines. Metal rollers pressed onto steel rods which press them against the wire pick up the current. The telpher is powered by 380 V three-phase current. It is controlled by means of a portable console. Plants in Bransk supplied the materials and structures to construct the line. The line is operated by a single man and it can be used for the purpose of loading and unloading all heavy freight and equipment. The introduction of this line has resulted in an annual savings of 7800 rubles and safety has been improved as compared with the old method of transporting equipment by means of hand cars. Figures 3.

[47-8831]



USING SELENIUM PHOTOCELLS TO MEASURE LOW LIGHTING LEVELS

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 80 pp 20-22

ZELENER, M. F., All-Union Scientific Research Institute of Motion Picture Photography

[Abstract] The author discusses the feasibility and advantages of replacing silicon photocells with selenium photocells for measuring constant and slowly changing illuminances of less than 0.1 lx in systems made up of a photovoltaic receiver and an amplifier. It is found that off-the-shelf selenium photocells with cadmium oxide upper electrode in the short-circuit mode give a fairly flat current-illuminance response curve for most applications. Thermal compensation can be omitted or simplified thanks to the low temperature coefficient of sensitivity of selenium photocells, and the weak dependence of this parameter on illuminance. Selenium photocells have much greater integral sensitivity than silicon cells when corrected for the visibility curve because of their high sensitivity in the visible part of the spectrum as well as the favorable shape of the spectral response. The initial specific conductance  $g_0$  of selenium photocells is nearly independent of area, and at room temperature is 5-20 times lower than for silicon cells. This advantage is intensified as temperature rises. These advantages mean that these photocells can be used at a considerably lower sensitivity threshold with higher accuracy and stability than silicon cells. Since no special care was taken to keep initial conductance low, it should be possible to further reduce this parameter. The low production cost of selenium cells means that even today it is feasible to select photocells among series-produced items with a  $g_0$  of 5-20 nS/cm<sup>2</sup>, which is dozens of times lower than the best silicon cells. Selenium cells can be made with areas of several sq. cm in any shape, which is either impossible or very expensive for silicon cells. Figures 5; tables 3; references 3: 1 Russian, 2 Western.

[61-6610]

## DIGITAL VIDEO SIGNAL DELAY LINES BASED ON INTEGRATED MEMORY CIRCUITS

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9. Sep 80 pp 34-35

DUBITSKIY, V. I. and PODDUBNYI, Ye. V., Moscow Institute of Electronic Technology

[Abstract] A brief analysis is made of methods of realizing digital video signal delay lines based on integrated memory circuits, and equipment costs are evaluated. Two delay lines are proposed that contain shift registers, a matrix of memory crystals and a control device. The crystals of the memory matrix are arranged in rows and columns, and each crystal has information inputs, information outputs, address inputs, a crystal selection input and a recording-enable input. Like information inputs of all crystals in each column are connected to the corresponding information output of the first shift register, which converts the sequential code of the video signal to parallel code with a fixed number of digits. Like information outputs of all crystals in each column are connected to the corresponding information input of the second shift register, which performs reverse conversion of the parallel code to the sequential code of a video signal. The like address inputs of all crystals in the memory matrix are connected to the corresponding address output of the control device. Like crystal selection inputs in a given line are connected to the given output of the control unit. A recording-enable signal from the control unit is sent simultaneously to all recording-enable inputs of the memory crystals. In one delay line, a buffer shift register is added with number of digits equal to the number of information inputs of the memory matrix. This reduces the speed of the memory crystals that can be used, but increases the information capacity. The lower estimate of equipment expenditures depends on the number of lines and columns, and has a minimum for certain optimum numbers of lines and columns. Figures 2; references: 2 Russian.

[61-6610]

## TV TRANSMITTING TUBES WITH AUTOMATIC CONTROL OF EXPOSURE TIME

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 8, 1980 pp 36-38

GRYAZIN, G. N. and KRUMING, B. A., Leningrad Institute of Precision Mechanics and Optics

[Abstract] A discussion is presented of the principles of the design of TV transmitters with automatic control of the exposure time, designed for operating in systems for observing rapidly moving objects. In order to create TV pulse transmitters with a controlled exposure time, two problems have to be solved: determination of the criterion and algorithm for optimizing the exposure time, and designing

equipment which will make it possible to regulate this parameter as a function of varying viewing conditions. M. V. Antipin's integral criterion for image quality (1970) is used as the criterion for optimizing the exposure time for systems for viewing rapidly moving objects. A procedure has been developed for calculating the optimal exposure time on the basis of the dependence of image quality on two variable magnitudes, i.e., the rate of movement of the image of the object and its illumination. A block diagram is presented of a TV pulse transmitter incorporating a special processor. The illumination and speed are entered into the processor as variables, discretely or continuously. Stored in the memory are the maximum signal-to-noise ratio, a factor depending on the type of superorthicon employed and the spectral composition of the illumination source, the relative boundary space density of the communications channel, and the space-density characteristic of the system with a stationary object. The processor forms at the output a voltage proportional in magnitude to the optimal exposure time, which is then supplied to a voltage-to-time converter together with pulses for beginning the exposure. These pulses enter from a sensor of the object's position in space and serve the purpose of triggering the converter. The converter's output pulses, which are equal in duration to the optimal exposure time, are supplied by means of a shaper to the photocathode of the superorthicon, which operates with an electronic shutter. Also described is a stroboscopic transmitter for transmitting oscillating images, which is provided with special equipment making it possible to hold the exposure time constant when the frequency of oscillations varies over a wide range. A structural diagram is presented of a similar transmitter which contains equipment for optimizing the exposure time in relation to a change in the amplitude of oscillations and illumination of the object. A block diagram is presented which explains the principle of designing a system with automatic control of the exposure time regardless of the type of movement. Figures 4; references: 4 Russian. [24-8831]

UDC 621.391.837:621.397.13

# GENERAL-PURPOSE TELEVISION UNIT FOR PHOTOGRAPHIC RECORDING AND READING FROM MICRO-FILM

Moscow TEKNIKA KINO I TELEVIDENIYA in Russian No 8, 1980 pp 43-45

CORELIK, S. L., ROZENoyer, V. Ya. and SEMENOV, Ye. F., All-Union Scientific Research Institute of Television

[Abstract] Methods are discussed for expanding the functional capabilities of photographic recording equipment employing projection cathode ray tubes with a fiber optic faceplate, by shifting to digital control of scanning and optoelectronic transformation of the shape of the electron beam's cross section, and unifying its operation both in the photographic recording mode and in the scanning beam mode. The unit described can be used for photographic recording of broadcast-standard TV images or images of small-frame scanning systems while changing resolution parameters, i.e.,

the number of elements in a line and the number of lines in a frame. The first mode can be used in reading out images from a computer in combination with a television display, and the second in the digital control of scanning directly from a computer. The unit makes it possible to read images from photographic film for transmission through a communications channel with subsequent reproduction on the screen of a display, photographic recording or the entry of data into a computer, as well as to process images for the purpose of improving their quality or for separating the most informative traits before entry into a computer communications channel or after read-out from a computer. The unit utilizes a 4LK1L projection cathode ray tube and is designed to use standard 35 mm perforated photographic film, such as KN-2 and KN-3. The image on the film measures 18 X 24 mm. Changing from the recording mode to the playback mode is accomplished by replacing the cassette with the photographic film with a cassette with a transparent frame window. The latter cassette contains an FEU-55 multiplier phototube and a video preamplifier. The output of the latter is connected by means of a video signal processor to the communications channel, the unit for reproducing the processed data, or to the input registers of a computer. The shape and orientation of the cross section of the electron beam are controlled by means of an optoelectronic system containing a combination of axisymmetric and double quadrupole lenses. The shape of the electron beam's cross section can be varied from circular to dash-type and the dashes can be oriented in any manner. Because of the wide range of variation of parameters of the aperture and raster, it is possible to perform a number of operations for processing the image to be read out or reproduced. This makes it possible to improve the quality of images. Figures 4; references: 2 Russian. [24-8831]

UDC 621.397.2.037.372

#### OPTIMUM FILTRATION OF A DIGITAL TV SIGNAL

Moscow TEKHNIIKA KINO I TELEVIDENIYA in Russian No 9, Sep 80 pp 38-41

KRYMMER, L. N., SEMIRECHENSKIY, I. B., TSYRGANOVICH, A. V. and SHERAYZIN, S. M., Minsk Affiliate of the All-Union Electrical Engineering Correspondence Institute of Communications

[Abstract] A method of quasi-linear filtration is developed for application to problems of processing a TV signal based on a multivariate description and classification of a TV signal by a finite-dimensional alphabet of symbols. It is shown that optimum filtration of a TV signal must be adaptive in order to ensure maximum suppression of jitter with permissible distortions. It is advisable to break down the set of image elements into two equivalence classes. A criterion for permissible distortions is introduced that assigns filter parameters which ensures transmission of images with distortions below the threshold of visual perception for each information parameter. The proposed filtration method has latitude for improvement by introducing adaptive filtration within the equivalence classes, and also by intraframe and interframe signal processing. Figures 4; references 15: 12 Russian, 3 Western.

[61-6610]



## TELEVISION IMAGE OF THE FUTURE

Moscow TEKNIKA KINO I TELEVIDENIYA in Russian No 8, 1980 pp 4-11

RYFTIN, Ya. A., Leningrad Electrotechnical Institute imeni V. I. Ul'yanov-Lenin

[Abstract] The sharpness of a TV image is inadequate. Here, on the basis of the capabilities of our vision and viewing conditions, the optimal characteristics are established for a TV image toward which it is necessary to strive in developing the next generation of TV systems. Optimal characteristics are established for perception of the green component of a color image, inasmuch as the requirements for perceiving it are the same as both for a black and white image and for a color image in general. A theoretical discussion is offered of the maximum sharpness of a TV image. The brightness of a TV image of a certain height,  $H$ , observed at a distance of  $A$  at an angle of  $\alpha$  depends on the number of lines,  $Z$ , which is determined by the angle,  $\beta$ , resolvable by the eye. Whereas angle  $\alpha$  depends only on the relative viewing distance, angle  $\beta$  is conditioned by many factors, foremost among them the illuminance of the image,  $E$ , and the depth of intensity modulation,  $M$ , in parts of the image. A study was made of the dependence of angle  $\beta$  on these two factors, using an apparatus containing a receiving tube with a practically white screen with illuminance of  $E = 150$  lx. To this tube's modulator sinusoidal voltage was supplied whose frequency was held at a multiple of the frequencies of lines and frames. Thereby vertical bands were observed on the screen whose visual distinguishability depended on the modulation of the signal,  $M_s$ , and the distance,  $A$ , of the viewer from the screen. It was shown that with an increase in  $M_s$  the angle resolvable by the eye is reduced and the visible sharpness,  $S = 1/\beta$ , increases approximately in proportion to the logarithm of  $M_s$ . The results of the experiment establish that angle  $\beta$  determining the number of lines depends not only on  $E$  and  $M$ , but also on the shape of the curve for the change in brightness in parts of the TV image. Also discussed are unavoidable limitations, the optimal number of lines, the characteristics of an optimal TV system, limitations which can be avoided, and the difference between the nominal and apparent sharpness of an optimal TV image. Angle  $\beta$  is restricted primarily by diffraction and aberration scattering of light in the camera lens, by the finiteness of the resolving elements of the transmitting and receiving tubes, and by the transmission band of the communications channel. It is demonstrated that the optimal number of lines equals 1240, which is almost double the 625 now used as the standard. To achieve this number it is necessary to broaden the transmission band of the channel to 28 MHz. These figures are arrived at for the majority of TV viewers, who watch at a distance of  $A = 4H$  from a screen with a 4/3 format. With the resolution of the lens and tubes increased twofold and the transmission band of the communications channel broadened fourfold to 28 MHz, the sharpness of the TV image would increase fourfold. A further increase in these parameters is difficult to implement and is unjustified out of practical considerations. Figures 10; references 12: 10 Russian, 2 Western.

[24-8831]

## CENTRAL CONTROL ROOM OF THE OLYMPICS TELEVISION AND RADIO CENTER

Moscow TEKHNIIKA KINO I TELEVIDENIYA in Russian No 8, 1980 pp 46-55

KRYLKOVA, V. P., SHABSKIY, K. K. and SHERMAN, S. A., All-Union Scientific Research Institute of Television and Olympics Television and Radio Complex

[Abstract] The Olympics Television and Radio Center was created as a permanent structure and consequently the broadcasting technology of the future was taken into account in designing it. Great attention was paid to the design and equipment of the central control room. The key functions and objectives of the central control room have been defined as follows: correction of the distribution to users (program equipment units, video recording control rooms and other control rooms included in the structure of the Olympics Television and Radio Center) and the switching of video and audio signals from program sources situated both within the center and at sports facilities in Moscow and other cities; the complete shaping of signals for 20 international broadcast stations; the centralized synchronization of all external program sources such as mobile TV stations at sports facilities in Moscow and other cities, and of the center's internal program sources; automated monitoring of video channels by means of test signals; and tolerance testing of the level parameters of the video signal in the external outputs of the central control room. A functional diagram is given of the video equipment of the central control room and an illustration is given of the internal connections and of interaction between the central control room and other control rooms of the center. A detailed description is given of switchboard array A, which makes it possible to switch any of 50 input signals to any of 64 outputs. This array was installed solely for the purpose of the Olympics but it can be used elsewhere afterwards for different purposes. It has an independent control system. Array B makes it possible to switch 150 input signals to any of 288 outputs. A description is given of the system for internal monitoring of the central control room switchboard arrays, of the system for remote control of program transmitters, of the synchronization equipment, the time indication equipment and the audio equipment. The key technical parameters of the central control room equipment are given, in general, and of the television and audio systems individually. Figures 9; references: 3 Russian.

[24-8831]

## MEASURING THE FREQUENCY DEVIATION OF TV IMAGE SIGNALS

Moscow TEKHNKA KINO I TELEVIDENIYA in Russian No 8, 1980 pp 38-41

SHAPIRO, L. Ya. and BOGDANOV, V. P., All-Union Scientific Research Institute of Television

[Abstract] It is difficult to measure the frequency deviation of an FM TV image transmitter because of the complex shape of the modulating signal, which varies from subject to subject, its broad frequency spectrum, occupying the frequency band up to 6 MHz, and the high amount of frequency deviation, of 10 to 12 MHz. Deviometers must be developed which are based on a design principle which makes it possible to take these factors into account and to guarantee the required measuring precision of three to five percent. Here a summary and classification are given of familiar methods of measuring the frequency deviation of FM TV image transmitters, as well as of new methods making it possible to monitor frequency deviation automatically and to improve the accuracy of TV deviometers. TV deviometers should be designed on the basis of methods of measuring frequency deviation from a separated envelope of the FM signal. The two basic methods employed are that of matching and that of a direct estimate. The matching method makes it possible to create precise deviometers for testing purposes and the direct estimate method makes it possible to develop less precise but more direct deviometers which make it possible to automate the measuring process. The matching method employs an oscillographic readout or a pointer or digital display and the basic instrument employed is a measuring oscillator of a frequency meter. The direct estimate method employs calibration and periodic calibration, the basic instrument for which is a pointer or digital voltmeter, and automatic calibration, the basic instrument for which is a digital ratio meter. In the automatic calibration method the calibration and TV signals are either separated in the digital ratio meter or in the analog portion of the equipment. Block diagrams are given of a TV deviometer operating by the matching method and of an automated deviometer operating by the direct estimate method. The former is recommended for use as a testing instrument with a margin of error of one percent. It is demonstrated that the method suggested for periodic calibration and automatic calibration makes it possible to ensure higher metrological reliability of measurement results as compared with the calibration, or frequency detector, method. The periodic calibration method has been implemented with measurement precision of not worse than three percent. It is possible to automate more completely the measurement of frequency deviation by employing the automatic calibration method and separating the calibration and TV signals in time in the digital portion of the pulsed voltmeter. Figures 3; references: 11 Russian.  
[24-8831]

## CHROMINANCE UNIT FOR COLORING INFORMATION SIGNALS

Moscow TEKHNKA KINO I TELEVIDENIYA in Russian No 8, 1980 pp 56-57

FOMINA, O. L., Kirovograd Radio Products Plant

[Abstract] A description is given of a chrominance unit designed for coloring information signals formed for display on the screen of a video monitor. The information can be presented in the form of symbols or graphic or stylized diagrams and signals for the primary colors, red, green and blue, are formed in the unit's output. A circuit diagram is given for the chrominance unit. It includes a decoder which converts a three-bit color code entering the unit's input into signals for seven colors: white, purple, blue, azure, green, yellow and red. The decoder is assembled from E3, E4 and E5 microcircuits. The data signal also enters the input of the decoder so that seven signals are produced in the decoder's output, after which the data signal enters the appropriate emitter follower. The level of the information signal can be changed by means of a resistive divider in the emitter follower's input. Red, green and blue signals are formed by the appropriate joining of the outputs of the emitter followers. The emitter followers for red, yellow, purple and white are joined by the red signal shaper, since red is present in these colors, for example. A white background signal is formed for improved separation of the information signal on the screen of the monitor. A single information line can be colored in several colors. Figures 1.

[24-8831]

UDC 621.397.611 videomagnitofon

## A FREQUENCY MODULATOR-DEMODULATOR SYSTEM FOR A VIDEO MAGNETIC TAPE RECORDER

Moscow TEKHNKA KINO I TELEVIDENIYA in Russian No 9, Sep 80 pp 42-44

VAYMBOYM, A. V., MUKHIN, N. M. and KHARITONOV, M. I., All-Union Scientific Research Institute of Television and Radio Broadcasting

[Abstract] For purposes of recording and playback of TV images on magnetic tape, the TV signal must undergo conversion in order to match its parameters with the characteristics of the recording-playback channel. In video recorders this is usually done by frequency modulation of the carrier frequency by the video signal with reverse conversion of the FM signal to a video signal in playback. The authors describe features of design of a frequency modulation/demodulation system and give basic technical specifications of such a system based on the frequency modem system developed for the Kadr-5 studio video recorder. A block diagram is given for the entire system plus schematic circuit diagrams of the modulator, limiter and pulse shaper, filter and phase corrector. Figures 5; references: 2 Russian.

[61-6610]



## ACOUSTIC INSULATION OF A SOUNDSTAGE

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 80 pp 17-19

KOZLOV, Yu. Ya., All-Union Scientific Research Institute of Motion Picture Photography

[Abstract] In designing a sound studio, it is important to keep the acoustic insulation  $R$  of the enclosure as close as possible to the required figure  $R_{\text{req}}$  because deviations to either side can lead to excessive cost ( $\Delta R > 0$ ) as well as to impermissible noise ( $\Delta R < 0$ ). In this paper the author derives formulas for determining acoustic conditions in the sound studio as a function of  $R$ ,  $\Delta R$  and some parameters of the microphone used in recording. Evaluation of acoustic conditions is based on the acoustic comfort criterion, which requires that the difference between the permissible and measured noise levels should be a non-negative number. Tables are given for the expected changes in probabilities of disruption of acoustically favorable conditions for sound recording in a given direction by various noise sources, and for the permissible deviation of acoustic insulation of an enclosure from the required figure for microphones with various response patterns: circle, cardioid, supercardioid, hypercardioid and figure-eight. Figure 1; tables 2; references: 3 Russian.

[61-6610]

UDC 771.449.76

## MC-LN COMPENSATING INTERFERENCE LIGHT FILTERS FOR LIGHTING EQUIPMENT WITH METAL HALIDE LAMPS

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 8, 1980 pp 12-18

KURITSYN, A. M., SINICHEVA, I. A., KHOMYAKOVA, F. T. and SHLYAKHTER, Ye. M., All-Union Scientific Research Motion Picture Photography Institute, Television Technical Center imeni the 50th Anniversary of the October Revolution and the Lytkarino Optical Glass Plant

[Abstract] Metal halide lamps have a color temperature close to daylight. Difficulties in ensuring stability with regard to color transmission are encountered in attempting to develop metal halide lamps with a color temperature of 3200 °K. As a result, yellow color compensating filters are used in order, for example, to make it possible to use these lamps together with incandescent lamps. The filters used are of the interference type, which makes it possible to achieve an output of 45 to 50 lu/W, as opposed to 90 to 100 lu/W for an unfiltered metal halide lamp and not greater than 30 lu/W for an incandescent lamp. A description is given of the various filters manufactured by foreign firms for foreign metal halide lamps. Described in

great detail is the MC-LN line of interference compensating light filters for lighting equipment with metal halide lamps of the "Raduga" and "Lyuks" type, manufactured in the USSR. A description is given of the spectrozonal system used to evaluate and test MC-LN filters. This is a three-zone method whereby the radiation is evaluated by means of two spectrozonal coefficients equal to the blue-red and green-red ratios of effective energy in three zones of the spectrum. These criteria are consistent with the spectral sensitivity curves of layers of color negative film, taking into account the characteristics of the average motion picture photographic lens. The filters were developed on the basis of catalogue data and samples of metal halide lamps. Spectrozonal characteristics are shown for series-produced DRISH-575 lamps, which have an average color temperature of 6000 °K, presently with a deviation exceeding the tolerance limit of  $\pm 500$  °K. Calculated curves are shown for the spectral transmission of an MC-LN light filter. On the basis of measurements of the spectral transmission of experimental samples and of their spectrozonal coefficients, it was found that light filters closest to those required can be produced by employing a six-layer coating of ZnS and  $MgF_2$  with an optical thickness of each layer equal to  $\lambda/4$  and six-layer coatings of ZnS,  $MgF_2$  with a sixth layer in the form of SiO with the same optical thickness of each layer. MC-LN interference compensating light filters have been developed for the "Raduga" series of projectors with 1200, 2500 and 4000 W DRISH lamps and for the "Lyuks" series of floodlamps with 575 W DRISH lamps and 1000, 2000 and 3500 W DRI lamps. These filters are installed on the outside. The results are given of studies of the temperature and heat resistance of MC-LN filters when used with various lamps held in various positions. Measurements of all characteristics of the filter were performed with a specially developed unit for testing light filters which makes it possible to determine both the spectrozonal and color characteristics of light sources and filtered radiation under plant and laboratory conditions. It consists of a light source which creates a parallel beam of light to be filtered by the filter being tested and a colorimetric attachment. The results are given of a subjective color test comparing the illumination of a blue, green, red and yellow card by means of a halogen incandescent lamp and a "Lyuks-575" with a DRISH-575 metal halide lamp and an MC-LN light filter. The results were for the most part judged to be identical on a video monitor, with the exception of the yellow card which showed a slight lemon tinge when illuminated with the MC-LN filter and metal halide lamp combination. Figures 6; tables 5; references 8: 7 Russian, 1 Western.

[24-8831]



UDC 771.531.351.5:778.6].023.415.224

ENHANCING THE LIGHT SENSITIVITY OF TsO-32D MOTION PICTURE FILM DURING PROCESSING

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 80 pp 22-24

BAGAYEVA, G. G. and SHUBERT, M., Leningrad Institute of Motion Picture Engineers

[Abstract] Studies are done on three kinds of AgHal developer for use as the first developer in processing TsO-32D color reversal film. It is shown that the addition of sodium bromide in amounts of 2-2.5 grams per liter increases the light sensitivity of this film without any change in the processing conditions. Figure 1; tables 2; references 3: 2 Russian, 1 Western.  
[61-6610]

UDC 772.932.45

THERMOPLASTIC VIDEO RECORDING AND INSTANT PLAYBACK

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 80 pp 24-26

BARATOV, A. G., ROMANYUK, V. R., FEDOROV, I. G. and SHISHKIN, V. S.

[Abstract] A thermoplastic video recording device is described in which the thermoplastic film is charged by electron beam and developed by rf heating. The image can be played back within 200-300 ms after recording. Curves are given showing resolution as a function of temperature for different kinds of thermoplastic film. Recording is done at 25 frames per second on 16 mm thermoplastic film. Figures 5; references: 4 Russian.  
[61-6610]

## EMPLOYMENT OF COMPUTER FOR DYNAMIC BALANCING OF PULL-DOWN MECHANISMS

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 8, 1980 pp 18-20

IODKOVSKAYA, O. K. and SHCHERBAKOVA, N. I., All-Union Scientific Research Motion Picture Photography Institute

[Abstract] A procedure is presented which makes it possible to make a theoretical study of the dynamic balancing of complex pull-down mechanisms in motion picture cameras. Uneven motion of the components of a pull-down mechanism results in forces of inertia which bring about dynamic loads in kinematic pairs and are the sources of vibrations transmitted by means of the mechanism's support to the body of the camera, which results in undesirable noise. A theoretical model is presented which takes into account the inertial properties of a pull-down mechanism. For a theoretical solution to the problem of balancing the forces of inertia of the components of a film pull-down mechanism it is sufficient to know the masses of the components and the positions of the centers of these masses, as well as the kinematic characteristics of the pull-down mechanism. The employment of a computer makes it possible to facilitate a great deal the selection of the counterweight's mass and its position. The positions of the centers of mass of the mechanism's components are determined as a function of the angle of turn of the driving crank. Equations are presented for determining the position of the overall center of mass of the mechanism and the resulting force of inertia and its components relative to the X and Y axes. An equation is then given for the resulting moment of inertia. It is demonstrated that placing a counterweight of optimal mass on the drive shaft of a pull-down mechanism reduces the force of inertia by 21 percent. A table of data is given on the relative change in the maximum force of inertia for several variants of balancing the mechanism's components. An analysis of the results of these variants makes it possible to conclude that the resulting force of inertia can be reduced substantially by employing a balancing method whereby the center of gravity of the balance arm is brought to the axis of the support and the center of gravity of the grabbing device to the axis of the crank's link. By means of this method the maximum force of inertia is reduced to seven percent of that of an unbalanced mechanism. If, in addition, the shackle is balanced relative to the axis of the grabbing device's link, a result close to ideal is achieved. This method of balancing does not present design difficulties and does not involve a considerable increase in the mass of components. For a six-component crank-and-connecting-rod pull-down mechanism with a counterweight for the grabbing device, a greater than 90 percent reduction in forces of inertia can be achieved by balancing the connecting rod and balance arm relative to their links and installing an appropriate counterweight on the drive shaft. It is demonstrated that the traditional placement of the balancing mass on the drive shaft opposite the crank is not optimal for all balancing variants. Figures 2; tables 1; references: 7 Russian.

[24-8831]

## NON-SOVIET TECHNICAL DEVELOPMENTS: PYROELECTRIC VIDICONS

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 10. Oct 80 pp 60-66

MALAKHOV, I. K.

[Abstract] A brief survey of the latest developments in infrared imaging tubes based on vidicons with pyroelectric targets. These devices take advantage of the capability of certain ferroelectrics to change polarization when heated. Such a target reacts only to temperature change, and generates signals only when the temperature field is unsteady. Details are given on the input window, electron gun and target of pyroelectric vidicons. Data are given on the tubes now being made by Thomson-CSF (TH9840 and TH9851), EEV (P8090 and P8092), Phillips (S58XQ) and Heimann (E2130). An explanation is given of target polarization, maintaining generation by varying the temperature field, readout, target preparation, and shaping a unipolar video signal. Prospects for further improvement of pyroelectric vidicons are discussed, and infrared television systems are described. Figures 13; references: 17 Western.

[83-6610]

## INVESTIGATIONS IN THE FIELD OF DIGITAL TELEVISION

Moscow ELEKTROSVYAZ' in Russian No 9, 1980 pp 1-8 manuscript received 13 Dec 79

KRIBOSHEYEV, M. I. and KHOROBRYKH, V. T.

[Abstract] The state of affairs in the area of digital television is considered on the basis of documents of international organizations (International Consultative Committee for Radio communications; International Telegraph and Telephone Consultative Committee; International Organization of Radio Broadcasting and Television, European Broadcasting Union) and the contributions of a number of countries. The following subjects are discussed: 1) Purpose of work and an evaluation of its effectiveness; 2) Hierarchy of digital transmission systems; 3) Methods of coding and their classification; 4) Discretization structures; 5) Change of the discretization parameters; 6) Frequency band of signals being encoded; 7) Encoding of complete color signals; 8) Coding of components of a TV signal; 9) Separation of a complete color TV signal into components; 10) Compatibility of coding methods; 11) Measurement and monitoring in digital television; 12) Standardization of combined and digital channels; and 13) Principal directions of further investigations. Figures 11; tables 3; references: 8 Russian.

[72-6415]

## RELIABILITY OF DISCRETE DATA TRANSMISSION OVER TV CHANNELS

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 10, Oct 80 pp 43-46

REZNITSKIY, M. S.

[Abstract] An examination is made of the possibilities for improving interference immunity in systems for discrete data transmission over TV broadcast channels. It is shown that structures based on using products of codes give a considerable gain in reliability due to excellent correcting properties with respect to error bursts. A further improvement can be realized by the method of decorrelation, i.e., by spreading out the error burst with time division of the elements of each code word. The use of decorrelation in combination with a code that corrects two errors ensures excellent reliability in discrete data transmission. References: 1 Russian. [83-6610]

## SEPARATION QUALITY AND COLOR ANALYSIS IN A SINGLE-LENS STEREOCOLOR TV TRANSMISSION CAMERA WITH A CODING MODULE IN THE OPTICAL SYSTEM

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 10, Oct 80 pp 48-51

DUKLAU, V. V., Leningrad Electrical Engineering Institute of Communications

[Abstract] An examination is made of problems of meeting compatibility requirements in stereoscopic colorcasting with a system in which the stereopair images are produced by single-lens optics with a coding module. The coding module is installed in the iris plane of the transmitting camera, and consists of two color-separation filters that send different beams to the left or right half of the aperture. The color-separated signals are then coded by standard SECAM equipment and can be reproduced on the screen of a standard color set. The stereoscopic effect is produced by offsetting the vertical boundaries of the color-separated images of defocused flats lying nearer to and further from the pickup-plane of the long-focus lens. The author analyzes the capabilities of such a system for combining functions of separation and color analysis. Experimental data confirm the theoretical conclusions. Figures 3; references 5: 4 Russian, 1 Western. [83-6610]

## THE PTVS-3TsT MOBILE VIDEO RECORDING STUDIO

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 10, Oct 80 pp 52-53

ZEMBITSKAYA, T. M., KULINICH, T. V., NELIPA, V. I. and SHLYAKHOV, Yu. Z.

[Abstract] The article describes the PTVS-3TsT mobile video color recording studio that is in series production at the Kirovograd Radio Equipment Plant, and was successfully used at the 1980 Olympics in Moscow. The system makes extensive use of third-generation equipment with integrated circuitry and automated control. Three TV cameras are included with 20x zoom lenses. Two synchrogenerators ensure synchronous and cophased operation of equipment. Provisions are made for input from six external sources. Control booths are provided for the engineer and director. The sound recording equipment can be used for switching, amplification and control of signals from seven microphones, two tape recorders and three external sources. Supply is from a three-phase 220 V or 380 V power line, with consumption of 21 kW. The equipment is mounted on a specially designed KAMAZ-5420 semitrailer. Figures 2. [83-6610]

## COLOR FILTRATION OF AN IMAGE IN DIGITAL TELEVISION SYSTEMS

Leningrad IZV. VUZ: PRIBOROSTROYENIYE in Russian Vol 23, No 9. Sep 80 pp 72-76  
manuscript received 6 Jun 79

IGNAT'YEVA, N. V., TITOV, Yu. M. and FEDCHENKOV, K. A.

[Abstract] A variant of a compound television chromaticity filter for digital color filtration is described which includes an adder of R,G,B input signals in weighted binary codes, three decoders and two coincidence-circuit matrices, two encoders of chromaticity signals, two code comparators, and one output coincidence circuit. In the case of a single chromaticity etalon rectangle this structure can be simplified by elimination of the decoders and most of the coincidence circuits. The encoders can be eliminated, furthermore, when the truncation factors or the code shift, and thus the weighting coefficients are exactly in a certain relation to the two chromaticity coordinates of the etalon. The error of color filtration depends on the code difference, on the dynamic range of the sum signal, and on the degree of truncation. Expressions for the maximum error have been derived on this basis. The paper was recommended by the Department (Kafedra) of Television, Leningrad Institute of Electrical Engineering imeni V. I. Ul'yanov (Lenin). Figures 4; references: 2 Russian. [71-2415]

## PRINCIPLES OF CONSTRUCTION OF TELEVISION SYSTEMS FOR INFORMATION DISPLAY

Moscow AVTOMATIKA, TELEMEXHANIKA I SVYAZ' No 1, May 80 pp 7-9

BELYAYEV, A. I., senior scientific research worker of All-Union Red Banner of Labor Scientific-research Institute of Railroad Transportation (VNIIZhT), candidate of technical sciences

[Abstract] Use of television methods for presentation of information belongs to the general trend of development of devices for display of information for individual use. It is assumed that in the future standard television receivers will be used in conjunction with telephone and control units with a keyboard for an exchange of information with a remote computer via telephone cables. A block diagram is presented and a description given of a TV display (signal/mimic panel). This panel was developed and produced at the Division of Communication and Signalization and Interlocking of the All-Union Order of Red Banner of Labor Scientific-Research Institute of Railroad Transport. A set of symbols for the electron panel and an example of display of a station are presented. Figures 2.

[67-6415]



UDC 621.3.045.1-621.383.812

STRIP ALUMINUM FOCUSING COILS FOR IMAGE CONVERTERS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 228-229  
manuscript received 25 Aug 78, after revision 2 Apr 79

PIMENOV, V. F., RYLOV, V. S. and SKOSYRSKAYA, T. A., Special Astrophysical Observatory of the USSR Academy of Sciences, Zelenchukskaya

[Abstract] Among the advantages of aluminum band over copper wire for winding the focusing coils of image converters are lower weight, a space factor close to zero, better thermal contact between turns and greater ease of manufacture. The number of ampere-turns depends only on the resistivity and the space factor. The resistivity of aluminum is lower than that of copper by a factor of 1.63 at the same temperature. The authors describe focusing coils made of A99 aluminum band (GOST 618-73) 0.1 mm thick. An oxide layer 0.7  $\mu$ m thick was applied to both sides of the strip. Forming was done under voltage (600 V) at 25 m/hr. The coiled sheet (0.5 m wide) was then cut into strips 30 and 50 mm wide. The focusing coils were then wound on a hand machine with controlled tension. The end faces of the finished coils were then anodized. Tests showed that these coils perform at least as well as copper coils, and they are half as heavy. References: 2 Russian.  
[62-6610]

# INVESTIGATION OF THE ANGULAR STRUCTURE OF COSMIC SOURCES BY THE SCINTILLATION METHOD (SURVEY)

Gor'kiy IZV. VUZ: RADIOFIZIKA in Russian Vol 23, No 8, 1980 pp 893-918 manuscript received 11 Nov 79

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[Abstract] The observation of scintillations of cosmic radio waves in inhomogeneities of the interplanetary plasma is a simple and effective method of studying the angular structure of cosmic radio emission. The emission of compact radio sources undergoes diffraction in passing through a medium with nonuniformity of its refractive index, resulting in the fact that in the plane of observation spatial fluctuations in the intensity of the emission occur. These spatial fluctuations are perceived by an observer as time fluctuations, i.e., as scintillations, when the inhomogeneities of the medium move relative to the line of sight. The scintillation method is based on these phenomena. The method's resolution is restricted by the dimensions of the diffraction diagram and the signal-to-noise ratio. In order to study the angular structure of emission sources it is necessary to know the parameters of the medium causing scintillations, but even with approximate data on the medium this method makes it possible relatively easily to find sources with small angular dimensions without resorting to more cumbersome methods. Recently the scintillation method has become widely used for studying the angular structure of cosmic sources and for diagnosing the interplanetary plasma and the ionosphere. A summary is given here of the key results of research on the angular structure of compact sources by means of the method of analyzing scintillations of radio waves in inhomogeneities in the electron density of the interplanetary plasma. The survey concentrates on measurements made in the last few years and on an interpretation of them. A brief historical survey of progress in application of the method is given. The considerable improvement in the sensitivity of radio telescopes taking place in the 70's made it possible to use the scintillation method for studying the angular structure of weak sources. Over the 15 years which have passed since the beginning of systematic observations of scintillations a great amount of experimental data has been collected, it has been shown that inhomogeneities of the interplanetary plasma have a power-law spectrum, a theory has been developed for slight and strong scintillations and the subject matter open to research by this method has been expanded. An analysis of these data is given with a discussion of theoretical models of scintillations of radio waves in inhomogeneities of the plasma about the sun. In the observation of scintillations the directly measured quantity is the intensity of the source at a given moment of time and fluctuations of this intensity. The space-time intensity correlation function is given for variations in fluctuations in intensity in space and time. A discussion is given of the relationship between parameters of the medium and the characteristics of scintillations. Definitions are given of some characteristics of the medium. The correlation function is given for fluctuations in electron density and the expression is given for the dielectric constant of the medium for radio waves propagated in the interplanetary plasma. Also given for fluctuations in the electron density of the medium is the so-called structure

function, in the form of the mean square of the absolute value of the increase in the fluctuation component. It is demonstrated that the study of the observable characteristics of scintillations and of properties of the medium can be reduced to a study either of spectra or of correlation, or structure, functions. The relationship between characteristics of scintillations and parameters of the medium can be gotten by solving the problem of wave propagation in a medium with fluctuating parameters. This problem is solved by approximation methods. It is demonstrated that theoretical models utilizing the assumption of a power-law kind of spectrum for turbulence of the interplanetary plasma make it possible to make a correct estimate not only of the angular dimensions of scintillating components, but also of their flux. A summary is given of important results of scintillation observations. It is concluded that the scintillation method is a powerful tool for studying the interplanetary plasma and the angular structure of discrete sources. Observations of scintillations make it possible in conjunction with observations of the variability of the flux of radio sources to detect simply the possible manifestation of compact components in nonstationary objects. This is very important for an understanding of the nature of these objects. In spite of the successes achieved thus far, there have been few surveys of the scintillation of discrete sources and the problem of systematic cartography of the space above the sun by means of radio methods has not been ironed out. The only sufficiently complete survey has been at a frequency of 81.5 MHz. Work at lower frequencies is necessary, for in this region considerable variation has been observed in the angular structure of sources, and methods of very-long-baseline interferometry have been given little development. The author thanks S. Ya. Brauda for the suggestion to write the survey, constant interest in the work and helpful council; and V. P. Bovkun for fruitful discussions in the process of work on the survey. Figures 7; references 121: 46 Russian, 75 Western.  
[37-8831]

UDC 523.164:621.391.26

#### CLEARING OF ATMOSPHERIC NOISE FROM RADIO ASTRONOMY IMAGES OF EXTENDED OBJECTS IN MULTIWAVELENGTH RECEPTION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1655-1667  
manuscript received 4 Jun 79

KAYDANOVSKIY, M. N. and STOTSKIY, A. A.

[Abstract] A key factor limiting the actual sensitivity of microwave radio telescopes is fluctuations in the self-radiation of the earth's atmosphere. A method for suppressing atmospheric fluctuations is discussed here which does not impose any limitations on the dimensions of the sources observed. This method is based on the difference between the radiation spectra of the atmosphere and of cosmic radio sources. In the microwave band this difference is great, for the intensity of the atmosphere's radiation increases rapidly, and the brightness temperature of the majority of radio sources drops rapidly, with an increase in frequency. Consequently,

when observations are made at several wavelengths the signal from the source predominates at a longer wavelength and the signal from the atmosphere at a shorter. The radio image of a source produced at a longer wavelength can be cleared by utilizing information on atmospheric fluctuations obtained at a shorter wavelength. A practical clearing algorithm is described which takes into account such facts as shifts in the directivity diagrams of radio telescope antennas and differences in the width of these diagrams at different wavelengths and the intrinsic noise of the radio telescope itself. The results are given of investigations performed with a "RATAN-600" radio telescope in the microwave band at low zenith angles in a cloudy atmosphere. The results are given of tests of the clearing method under real conditions in radio telescope observations of the Rosette Nebula (NGC 2237). Observations were performed with a "RATAN-600" radio telescope at wavelengths of 2.08, 3.9 and 8.2 cm with a resolution of  $0'.24 \times 1'.6$ ,  $0'.45 \times 3'.0$  and  $0'.93 \times 6'.2$ , respectively. Experiments on the suppression of atmospheric noise caused by the radio emission of clouds have demonstrated that it is possible to obtain a five- to 10-fold reduction in atmospheric noise as the result of the clearing method described. Low-frequency fluctuations are suppressed to a greater extent, representing high ranges of brightness temperatures; these fluctuations have the strongest negative influence when observing extended sources. The effectiveness of the clearing method depends considerably on the difference between the radio emission spectra of the atmosphere and of the cosmic source and on the correlation of fluctuations of the atmosphere's radio emission at various wavelengths. For the purpose of achieving high clearing effectiveness wavelengths must be selected so that on the one hand differences between the brightness temperatures of the source and atmosphere will be maximal, and on the other hand the high degree of correlation of atmospheric fluctuations must be preserved. High correlation of the radio emission of a cloudy atmosphere is maintained practically over the entire SHF band. Figures 7; references 7: 6 Russian, 1 Western. [44-8831]

UDC 621.376.43

PULSE-PHASE DETECTOR FOR FREQUENCY SYNTHESIZERS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 118-120 manuscript received 5 Dec 78

DRUGOV, M. I., KARYAKIN, V. L., SOLOV'YEV, M. Yu. and STEPANOV, N. N., Kuybyshev Electrical Engineering Institute of Communications

[Abstract] A pulse-phase detector circuit of the sample-storage type is proposed that gives 110 dB suppression of the reference frequency for use in frequency synthesizers with a low spurious signal level. The circuit includes a slave oscillator that generates linearly changing voltage, an electronic switch with storage capacitor, a source follower based on a field-effect transistor, and a nonlinear filter. The detector can operate over a frequency range from about 1 Hz to  $10^5$  Hz. The maximum output voltage is 9 V, and the level of the first harmonic of the comparison frequency at the output does not exceed -100 dB with respect to a potential of 1 V. Figures 2; references: 2 Russian.  
[62-6610]

UDC 621.372:621.391.82.01

AUTOMATED LITERAL CALCULATION OF THE NOISE FIGURE OF ELECTRONIC CIRCUITS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2252-2254 manuscript received 3 Aug 79

OSTAPENKO, A. G. and POLIKARPOV, E. D.

[Abstract] A generalized procedure is proposed for determining the noise figure of electronic circuits by using graphs, and a method is given for automating derivation of literal equations for calculating the noise figure. The description of noise properties is based on the following model: 1) The electronic circuit is represented by a set of reciprocal and nonreciprocal two-terminal networks between circuit components; 2) Connected in parallel with each of these networks is a noise source with parameters determined by the noise properties of the network; and 3) It is assumed that the noise sources are uncorrelated. The corresponding algorithm is given for automated literal calculation with an example showing the noise model of a transistor



and the corresponding topological graph of the model. The structure number derived from this graph was used in a computer program on the "Minsk-32" to get an analytical expression for the noise figure which in this case completely coincides with data in the literature. Figures 3; references 5: 4 Russian, 1 Western (in translation). [80-6610]

UDC 621.374

#### OPTRON SWITCHING CIRCUITS WITH DIODE OPTONS

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 9, 1980 pp 26-27

CHURBAKOV, A. V., candidate of technical sciences

[Abstract] The article acquaints developers of electronic equipment with various basic optron switching circuits using discrete elements with diode optons, and also discusses some ways to increase the speed of such circuits. An analysis is made of factors that determine wavefront delay in optron switching circuits based on the specific example of type K249LP1 and K293LP1 ICs. It is shown that such delay can be reduced by either reducing threshold voltages, increasing input current, or shortening the time constant. Each of these methods is considered separately. A high-speed circuit based on the AOD101V optron is proposed that produces output pulses with a rise time shorter than 0.2  $\mu$ s and a fall time shorter than 0.3  $\mu$ s and delays of 0.1-0.2  $\mu$ s. References: 3 Russian. [82-6610]

UDC 621.382.3:658.58.002.56

#### CHECKING OF WORKING ORDER OF TRANSISTORS IN CIRCUITS

Moscow AVTOMATIKA, TELEMEXHANIKA I SVYAZ' No 1, May 80 pp 26-27

POCHEPA, A. M., senior engineer of Odessa Electrical Engineering Institute of Communications

[Abstract] Methods are presented for checking the working order of semiconductor devices in the circuits of failed transistorized equipment. As an example the method of checking part of the circuit of a "VEF-201" low-frequency transistorized radio receiver and a one-transistor paraphrase amplifier are described. Figures 3. [67-6415]



UDC 621.372.852

INVESTIGATION OF THE CHARACTERISTICS OF A TWO-CHANNEL SIGNAL FREQUENCY SEPARATOR

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 87-90 manuscript received 5 Jun 79, after revision 3 Sep 79

VERLOOCHENKO, G. I. and OL'SHEVSKIY, A. L.

[Abstract] The article describes a two-channel frequency separator (diplexer) designed around directional couplers and band-elimination filters (series-parallel tank circuits). The device has four inputs. When a signal of frequency  $f_1$  is sent to the first input, its energy is split equally between the two arms of the first directional coupler, passing through filters to the outputs of the arms of the second directional coupler. The phase ratios of the signals in these arms are such that they are canceled out at the third input and added at the fourth input. When a signal with frequency  $f_2$  is sent to the third input, its energy is split equally between the two arms of the second directional coupler, reflected from the filters and added at the fourth input. The second input in either case on frequencies  $f_1$  and  $f_2$  is decoupled from the first and third inputs, which are also mutually decoupled. The second input is loaded by an impedance equal to the wave impedance of the feeder line. The characteristics of the circuit are analyzed and compared with experimental data. Figures 4; references: 2 Russian.  
[64-6610]

## EFFECT OF A TELEGRAPH SIGNAL ON A DYNAMIC SYSTEM OF THE FIRST ORDER

Gor'kiy IZV. VUZ: RADIOFIZIKA in Russian Vol 23, No 3, 1980 pp 998-999 manuscript received 17 Jul 79, after completion 10 Mar 80

BERDNIKOV, A. A., Leningrad Electrotechnical Institute of Communications

[Abstract] A theoretical investigation is presented the results of which make it possible to determine the unidimensional stationary distribution of the reaction of a dynamic system of the first order to the influence of an asymmetric random telegraph signal. A dynamic system of the following kind is discussed:  $\dot{x} = f(x) + g(x)n(t)$ ,  $t \geq t_0$  and  $x(t_0) = x_0$ , where  $f(x)$  and  $g(x)$  are determinate functions and  $n(t)$  represents an asymmetric random telegraph signal with two states,  $n_1$  and  $n_2$ . Process  $x(t)$  with  $t \rightarrow \infty$ , representing the stationary mode, belongs to the range of displacement of the point of stable equilibrium of the system when the random telegraph signal passes from one state into another. Conditional probability characteristics are introduced for the random process  $(x(t), n(t))$  with continuous component  $x(t)$  and discrete  $n(t)$ , and it shows that these characteristics satisfy a system of partial differential equations of the Fokker-Planck-Kolmogorov equation type. An equation is given for the transient probability density of process  $x(t)$  and the initial and boundary conditions are given for solving it. An equation is derived for the stationary distribution of process  $x(t)$ . The results arrived at can find an application, for example, in the generation of random processes by the method of electronic simulation of stochastic differential equations. References: 2 Russian. [37-8831]

## COMPENSATION FOR THE INFLUENCE THAT ANGULAR MISALIGNMENT OF THE FRONTS OF SIGNAL AND REFERENCE BEAMS HAS ON PHOTOCURRENT IN OPTICAL HETERODYNING

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2238-2239 manuscript received 30 Jul 79

ABRAMYAN, A. S. and KAZARYAN, R. A.

[Abstract] Some possibilities are discussed for compensating limited angular misalignment of interacting fields in an optical beat frequency oscillator that may relax requirements for alignment in infrared heterodyne reception. It is shown that compensation can be accomplished by simultaneous variation of either the angles of incidence or the optical frequencies of the plane monochromatic signal and heterodyne waves. In working with a CO<sub>2</sub> laser, a misalignment of the order of 40 angular seconds can be corrected by an adjustment of the order of 5° in the incidence of the signal wave. Figures 1; reference: 1 Western. [80-6610]

## INFLUENCE OF ALTITUDE PROFILE ON THE PHASE DIFFERENCE FLUCTUATIONS SPECTRUM IN TRANSMISSION OF RADIO WAVES BY A MOVING SOURCE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1767-1770  
manuscript received 7 Jun 79

ARMAND, N. A., KIBARDINA, I. N. and LOMAKIN, A. N.

[Abstract] Fluctuations in the phase difference of radio waves are governed by atmospheric inhomogeneities, the rate of transfer of which is assumed to be constant along the route for the case of stationary transmitters and receivers. In this case the fluctuation spectrum is determined by the transfer of atmospheric inhomogeneities across the propagation route and does not depend on the altitude distribution of the intensity of fluctuations in the dielectric constant of the atmosphere proportional to the altitude profile  $C_e^2(h)$ , but on the integral of this magnitude along the propagation route. However, when the transmission source is moving, the rate of transfer of inhomogeneities across the propagation route is determined by the altitude. Therefore, the phase difference fluctuation spectrum must depend on the altitude distribution,  $C_e^2(h)$ . A discussion of this dependence is presented which leads to the conclusion that in measuring phase difference fluctuation spectra by means of moving transmission sources it is necessary to take into account the fact that a change in the altitude profile  $C_e^2(h)$  can result in considerable distortions in the spectra. The behavior of the altitude profile of fluctuations in the dielectric constant can be evaluated from these distortions. Expressions are presented for phase difference fluctuation spectra obtained for a model of a plane stratified atmosphere with straight paths of movement of the transmission source at altitude  $H$  above the surface of the earth. The radio signal is received on the ground by means of an interferometer with base  $d$ . An anisotropic modification of Karman's model was used for the spectrum of fluctuations in the dielectric constant of the atmosphere. An expression is given for the spectrum of phase difference fluctuations normalized for the distance from the source to the receiver. From this expression it is concluded that the phase difference fluctuation spectrum depends on the state of the atmosphere, i.e., the magnitude of  $C_e^2(h)$ , the time reference point,  $t$ , and the path of travel. The altitude profile  $C_e^2(h)$  depends on many factors, including the time of year, weather conditions and the type of underlying surface. Experimentally recorded profiles differ both in magnitude and in the kind of altitude dependence. An exponential model is presented for describing qualitatively the behavior of profiles. A change in  $C_e^2(h)$  causes distortions in the spectrum which are the result of the fact that because of the movement of the source various layers of the atmosphere make a contribution to various frequency regions of the phase difference fluctuation spectrum. It is demonstrated that for certain frequencies the spectrum is determined by a region of altitudes in the atmosphere in which  $C_e^2(h)$  has a minimum and that therefore a minimum is also observed in the fluctuation spectrum in addition to a maximum. Figures 2; references 4: 2 Russian, 2 Western.

[44-8831]

## INFLUENCE THAT THE SURFACE OF THE EARTH HAS ON LONG-RANGE TROPOSPHERIC PROPAGATION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2033-2042  
manuscript received 20 Aug 79

IVANOV, V. V., KINBER, D. Ye., KORZHENEVICH, I. M. and STEPANOV, B. M.

[Abstract] Existing theories of long-range tropospheric scattering consider only single scattering by atmospheric turbulent inhomogeneities in the direct line of sight of both the transmitter and the receiver. As the distance between stations increases, so does the altitude of the space visible from both the transmission and reception side, and hence the increased scattering angle reduces the signal level. There is also a reduction in fluctuations of the index of refraction with increasing altitude. In this paper the authors propose a theory that accounts for effects of multiple scattering, including reflections and diffractions by the surface of the earth. Diffraction effects are accounted for by a geometric optics approximation. Calculations of the mean value and variance of the field in long-range tropospheric propagation show that signal fading is caused by both the spherical divergence of the wave and multiple scattering by atmospheric inhomogeneities. The solution of the problem agrees qualitatively with experimental data and with engineering calculations. The theory does not reflect the experimentally observed frequency dependence of tropospheric signal fading. References 9: 7 Russian, 2 Western. [80-6610]

## SPACE STRUCTURE OF THE REFRACTIVE INDEX NEAR THE LAND-SEA BOUNDARY

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1624-1628  
manuscript received 28 Jun 79

ANDRIANOV, V. A. and RAKITIN, B. V.

[Abstract] Based on solving the equation for turbulent diffusion in the atmosphere for the potential modulus of the refractive index of radio waves when using meteorological measurements on the ground, a two-dimensional radio meteorological model is developed for the boundary layer of the atmosphere near the land-sea boundary. The idea is developed that the space-time structure of the refractive index,  $N(\vec{r}, t)$ , in the boundary layer of the atmosphere at an altitude of up to 1 km can be determined by means of the following equation for turbulent diffusion for the potential modulus of the refractive index,  $\Pi(\vec{r}, t) : \partial \Pi / \partial t + (\vec{u} \cdot \nabla \Pi) = \text{div} (k \cdot \nabla \Pi)$ , where  $t$  represents time,  $\vec{u}$  the wind velocity and  $k$  the coefficient of turbulent diffusion.  $\Pi$  is related to  $N$ , the refractive index, in the boundary layer, as follows:  $N \approx \Pi + (g_N - g_\Pi)z$ , where  $z$  is the vertical coordinate and  $g_N$  and  $g_\Pi$  are vertical gradients of  $N$



and  $n$  for a standard radio atmosphere. The two-dimensional space structure  $N(x, z)$  is considered, where  $x$  is the horizontal coordinate under steady-state conditions in the presence of a land-sea boundary and the wind is assumed to be directed in the positive direction of axis  $x$ . Expressions are derived which describe the two-dimensional space structure of the refractive index,  $N(x, z)$ . Altitude profiles,  $N(z)$ , are shown at different distances from the coastline for the case when the wind is blowing from the sea ( $x < 0$ ) to the land ( $x > 0$ ). Experimentally measured values of the coefficient of turbulent diffusion, of the wind velocity, and of the sudden change in the refractive index usually taking place at the land-sea boundary were used in the calculation. It is demonstrated that the moist sea air with a high refractive index in passing over the dry land interacts with the surface of the ground by means of turbulent exchange and loses moisture, evidenced by a reduction in  $N$ , especially at the surface of the earth. The influence of the dry land extends to higher layers of the atmosphere in proportion to the distance from the sea and at distances of  $x > 100$  to  $300$  km the influence of the sea is practically not observed. Solving the two-dimensional problem of turbulent diffusion makes it possible to describe sufficiently precisely the anomalous subrefraction profile of  $N(z)$  experimentally observed above dry land with the wind blowing from the sea. Altitude profiles of  $N(z)$  are discussed for the case when the wind is blowing from the dry land to the sea. Profiles are shown for different distances from the coastline. It is demonstrated that dry air from the land with a relatively low refractive index in passing over the sea surface is saturated with water vapors on account of the effect of turbulent diffusion and the refractive index in the lower layers of the atmosphere increases rapidly. When the wind is blowing from the dry land superrefraction conditions for the propagation of radio waves are formed over the sea along the coastline. At a distance of  $x > 100$  to  $300$  km from the coastline the influence of the land ceases to be evidenced in the vertical structure of  $N(z)$ . Figures 3; references 8: 7 Russian, 1 Western.

[44-8831]

UDC 621.371.32.029.65

#### ESTIMATION OF HUMIDITY-DEPENDENT INDUCED ABSORPTION OF RADIO MICROWAVES IN THE EARTH'S ATMOSPHERE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25. No 9, Aug 80 pp 1763-1765  
manuscript received 18 Apr 79

GAYKOVICH, K. P. and NAUMOV, A. P.

[Abstract] A discussion is presented of the interpretation of the nonlinear, in terms of absolute humidity,  $\rho$ , part of the absorption of water vapor,  $\gamma_{nl}$ , and of the "excess" (as compared with theoretical values) linear absorption,  $\Delta\gamma$ , in relation to  $\rho$ , representing a key problem with regard to the propagation of radio microwaves in the earth's atmosphere. The coefficients are computed for the nonresonance absorption,  $\gamma$ , of electromagnetic energy by molecules of  $N_2$ ,  $O_2$  and  $H_2O$  caused by

induced dipole moments in binary collisions with molecules of  $H_2O$ . The additional absorption originating in  $N_2-H_2O$  and  $O_2-H_2O$  collisions is proportional to  $\rho$ , and absorption originating as the result of the additional polarization of molecules of water vapor during  $H_2O-H_2O$  collisions is proportional to  $\rho^2$ . A table of values is presented for  $\Delta\gamma$  and  $\gamma_{nl}$  at a number of wavelengths under standard atmospheric conditions at sea level with  $P = 760$  mm Hg,  $T = 293^\circ$  K and  $\rho = 7.5$  g/m<sup>3</sup>. Results are given for calculations of  $\gamma$  under standard atmospheric conditions at sea level in the wave number range of  $1/\lambda = 0$  to  $60$  cm<sup>-1</sup>. From a comparison of the calculation results and measured absorption coefficients it is concluded that at the present stage there is no alternative to the dimeric hypothesis for interpreting the nonlinear (in relation to absolute humidity) portion of the absorption of water vapor, even though this hypothesis has its problems, namely, the lack of sufficient experimental data on the considerable role of dimers in the atmospheric attenuation of radio microwaves. As far as the "excess" absorption of radio waves in atmospheric windows is concerned, the chief reason for discrepancies observed is the inadequacy of the description of molecular absorption by means of the form factors used for spectral lines. Figures 2; tables 1; references 17: 10 Russian, 7 Western. [44-8831]

UDC 621.371.34

# MEASUREMENT OF VERTICAL ATTENUATION OF RADIATION ON THE 4.1 mm WAVE IN THE EARTH'S ATMOSPHERE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2043-2046  
manuscript received 20 Aug 79

ISKHAKOV, I. A., SUKHONIN, Ye. V. and CHERNYSHEV, V. I.

[Abstract] Measurements were made of vertical attenuation in clear air, clouds and precipitation with respect to background radiation on a wavelength of 4.1 mm. The work was done in Gor'kovskaya Oblast at different seasons of the year over a two-year period in 1976-1977. The observations were done with a superheterodyne radiometer with band of 30 MHz and fluctuation sensitivity of 4 K at a time constant of  $\tau = 1$  s. The reception antenna was a rectangular horn measuring 54 x 540 mm. Zenith-angle scanning was by rotation of a flat metal reflector in front of the antenna 6 m away. Blackbody calibration was used. It was found that vertical attenuation in clouds on a wavelength of 4.1 mm usually exceeds vertical molecular absorption ( $\sim 1$  dB) only in the case of thick cumulus and stratus clouds. In the case of the most frequent rains with intensity of less than 10 mm/hr, vertical attenuation is about the same as in the case of thick cumulus clouds, about 3-5 dB. The statistical distribution of vertical attenuation over a 90-day measurement period shows that the maximum attenuation of 9 dB is observed 0.01% of the time. The authors thank A. G. Kislyakov and A. V. Sokolov for continued interest in the work and discussion of the results. Figures 2; tables 1; references 13: 4 Russian, 9 Western. [80-6610]



## USE OF QUASI-CONTINUOUS OSCILLATIONS FOR MEASURING SPECTRA OF SCATTERED RADIO SIGNALS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1766-1767  
manuscript received 27 Dec 78

STOTSENKO, O. F. and SHTERN, D. Ya.

[Abstract] A description is given of apparatus used to study the spectra of scattered radio signals by employing quasi-continuous oscillations, when the off-duty factor of pulses approximately equals two. This system makes it possible to preserve all the advantages of systems with continuous transmission while using a single antenna. The transmitter and receiver are connected to the antenna by means of a circulator. The decoupling made possible by the circulator must be sufficient to prevent burning out the diodes of the balanced modulator and mixer of the receiver's input units during a transmitter pulse. Modulating voltage is supplied to the balanced modulator from a reference voltage generator at a frequency much higher than twice the pulse repetition rate. The pulsed operating mode is achieved by modulation of the oscillations radiated by the transmitter and by gating by means of a switch for the voltage of the reference generator. Manipulated pulses are supplied from the modulator to the receiver's amplifier. In the quasi-continuous operating mode the width of the spectrum studied must be less than the frequency of the pulse repetition rate. A circuit diagram is given for a pulsed high-voltage modulator designed for modulating the high-gain traveling wave tube used as a power amplifier through the first anode. This modulator is used to reduce the leakage signal from the transmitter and the traveling wave tube's intrinsic noise by -70 to -90 dB in order to avoid overloading of the receiver and in order for the transmitter's noise not to worsen the receiver's sensitivity. Figures 2; references: 1 Russian. [44-8831]

## EXPERIMENTAL INVESTIGATION OF THE FIELD STRUCTURE IN A SUBMILLIMETER LENS LINE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1988-1991  
manuscript received 18 Jun 79

VERSHININA, L. N.

[Abstract] The results are presented of an experimental investigation of the amplitude-phase field over the length of one iteration of the line, i.e., the distance between lenses. An oscillator type backward-wave tube which generates waves with a length  $\lambda = 1.42\text{--}1.5$  mm was used as an oscillator. Measurements of the amplitude-phase field in the transverse section of the line were conducted by a method previously proposed by the author [Pribery i tekhnika eksperimenta, 1973, 2, 138]. Figures 3; references: 7 Russian. [68-6415]

## ONE METHOD OF SOLVING THE PROBLEM OF MATCHING AND DECOUPLING LINEAR DISSIPATIVE MULTITERMINAL NETWORKS

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-TEKHNIЧЕСКИХ НАУК in Russian No 1, 1980 pp 119-125 manuscript received 22 May 78

ONISHCHUK, A. G., MVIZRU [expansion unknown]

[Abstract] A study is made of the problem of simultaneous matching and decoupling in relation to input and output of a multiterminal network having an equal number of inputs and outputs,  $n$ , and described by a nonsingular wave transfer matrix,  $T$ . This problem can be solved by determining the transfer matrices of matching non-dissipative  $2n \times 2$ -terminal networks,  $T_a$  and  $T_b$ , installed in the input and output. It is demonstrated that it is possible to determine matrices  $T_a$  and  $T_b$  by solving matrix equations of the type  $T_a K_a = K_{a0} T_a$  and  $T_b K_{b0} = K_b T_b$ , where  $K_a$ ,  $K_b$  and  $(K_{a0}, K_{b0})$  are the pseudo-adjoint (quasi-diagonal) characteristic matrices of losses of a dissipative multiterminal network. A determination is made of the properties of these characteristic matrices. A passive signal transmission system is discussed, consisting of a dissipative  $2n \times 2$ -terminal network,  $T$ , connected to  $2n$ -terminal blocks of generators and loads. Matrix equations are given which describe completely the properties of this transmission system. The transmission quality of this system is evaluated by means of the transmission coefficient,  $A$ , or the loss factor,  $L$ , equal to the ratio of the effective power in the output,  $P_b$ , and input,  $P_a$ , of a  $2n \times 2$ -terminal network:  $K = L^{-1} = P_b/P_a$ . It is shown that it is possible to regard the transfer matrix as a linear operator acting in a space with an indefinite metric and to relate the solution to the problem of matching a  $2n \times 2$ -terminal network to a study of the properties of this operator. It is shown that if the dissipation parameters of the generator and load are known it is possible, by utilizing the properties of transfer matrices, to find the maximum permissible power of the generator and to determine the conditions for its transmission into the load. It is shown that random  $2n \times 2$ -terminal networks whose transmission operators are finite can be represented as a combination of three  $2n \times 2$ -terminal networks with specific transfer matrices corresponding to nondissipative multiterminal networks. These transfer matrices characterize the mismatch and coupling of the multiterminal network in question in relation to input and output. These matrices are nonsingular for a dissipative multiterminal network so that it is always possible to select matching multiterminal networks with inverse matrices  $T_a = T_1^{-1}$  and  $T_b = T_2^{-1}$ , which will compensate the influence of the multiterminal networks in question. A multiterminal network with the quasi-diagonal transfer matrix described is a network matched and decoupled simultaneously in relation to input and output. The solution to the problem of matching and decoupling a dissipative  $2n \times 2$ -terminal network can be reduced to determining matching  $2n \times 2$ -terminal networks whose transfer matrices,  $T_a$  and  $T_b$ , are the inverse of transfer matrices  $T_1$  and  $T_2$ . The theoretical discussion is illustrated by solving the following problem: In a transmission system let there be given a dissipative  $2n \times 2$ -terminal network with a nonsingular finite transmission operator,  $T$ . It is required to determine the transfer matrices of matching  $2n \times 2$ -terminal networks,  $T_a$  and  $T_b$ , with which  $L$  will take on a minimum value. Equations are derived which can be used in solving problems of synthesizing signal transmission systems with optimal noise and transmission properties. Figures 3; references: 11 Russian.

[42-8831]

## WAVEGUIDE LOOP COUPLING ELEMENTS WITH ELECTRICALLY CONTROLLABLE COUPLING

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1982-1984  
manuscript received 7 May 79

USOV, N. Yu.

[Abstract] Use in microwave transmitting systems of waveguide communication elements, the transient attenuation of which changes under the effect of a control signal, makes it possible to create a whole series of new microwave devices. A considerable broadening of the range of the working frequencies is possible in the case of the use of semiconductor structures which possess transverse or longitudinal distribution. The results are presented here of an investigation of the possibility of control of transient attenuation of waveguide loop coupling communication elements with the help of transverse- and longitudinal-distributed p-i-n structures. Figures 2; references 7: 3 Russian, 4 Western (1 in translation).  
[68-6415]

## THEORETICAL ANALYSIS OF NOISELIKE OSCILLATIONS IN ELECTRON WAVE SYSTEMS AND SELF-EXCITED OSCILLATORS WITH DELAY AND HIGH NONLINEARITY

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1683-1690  
manuscript received 2 Jan 80

KISLOV, V. Ya.

[Abstract] There has recently been great interest in studying noise-like oscillatory processes in systems with a low number of degrees of freedom. Systems and processes of this sort are customarily called stochastic because all the phase trajectories of the system are essentially unstable in the face of slight random disturbances, which are always present in a real system. Here the construction of electronic and radiophysical models of oscillatory systems providing for this stochastic behavior is discussed. The circuit diagram of the radiophysical model agrees with that of a classic self-excited oscillator with delay and contains an inertialess nonlinear amplifier with a signal,  $u$ , conversion function  $F$  or with a signal amplitude conversion function,  $X$ ; a filter with a linear transformation,  $\phi$ ; and a constant delay,  $T$ . A Van der Pol oscillator to whose anode or grid circuit is added a delay line,  $T$ , reduces to a circuit of this kind. The filtering transformation,  $\phi$ , is accomplished by means of an oscillatory circuit. Three approaches are formulated, by means of which it is possible to discuss the problem of the stochastic behavior of a self-excited oscillator with delay. The first two approaches reduce the problem

to solving discrete-difference equations which directly provide an algorithm for calculating any noiselike process, even very complex ones, not hitherto discussed in the theory of oscillations. The third approach consists of solving a differential equation which does not have a solution in regular form for the case of noiselike processes and thus makes it necessary to resort to numerical methods. These three approaches describe the radiophysical model of a stochastic oscillator with delay. The processes which they describe reflect real processes taking place in electron wave systems. Calculations are performed which demonstrate that it is possible to discuss with sufficiently strict validity processes taking place in oscillators with delayed feedback and high nonlinearity by solving discrete-difference equations arrived at on the basis of Kotel'nikov's theorem. The calculation procedure developed here can be further developed for the case of an electronic model of a self-excited oscillator when the amplitude conversion function is given in implicit form. Calculations performed by various methods demonstrate that in a self-excited oscillator system with delayed feedback and high nonlinearity the generation of a noiselike signal is possible. Stochastic behavior is realized most easily with a wideband filter and a long delay in the feedback circuit. The oscillator is characterized by determinate behavior with slight nonlinearity, a short delay and a narrow filter band. Broad ranges of stochastic behavior originate with high nonlinearity characterized by feedback of high intensity. Stochastic behavior disappears with a decrease in the product of the delay time and the width of the transmission band; in this way the models presented here conform to a classical oscillator of the Van der Pol type. Figures 7; references 10: 9 Russian, 1 Western (in translation).  
[44-8831]

UDC 621.376.56:519.2

# PROBABILITY CHARACTERISTICS OF ESTIMATE OF MESSAGE OF DIFFERENTIAL PULSE-CODE MODULATION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1873-1880  
manuscript received 27 Dec 78

KUZLENKO, N. I., PESIN, A. M. and PANOVA, L. V.

[Abstract] The analysis of differential pulse-code modulation (DPCM) is connected with considerable difficulties of a mathematical character and is often based on inexact approximations. This hinders an estimate of the efficiency of DPCM and its comparison with other known methods of discrete transmission of continuous random messages. Here, a precise determination is made of the statistical characteristics of DPCM, notably the univariate law of distribution of the estimate and the combined probability density of the input signal and the estimate signal at the output of DPCM, which is necessary during calculation of the mean square error of transmission of a continuous random signal in a communication system with DPCM. Figures 1; references 4: 1 Russian, 3 Western.  
[68-6415]



## CONCERNING THE CLASSIFICATION OF INFORMATION TRANSFER SYSTEMS

Moscow ELEKTROSVYAZ' in Russian No 9, 1980 pp 20-24 manuscript received 27 Jun 79

GUREVICH, V. E.

[Abstract] The principles are considered of the classification of information transfer systems, at the basis of which a method is placed for presentation of communications in a given system. This method of classification is universal, embracing all transfer systems known at present, and is in keeping with the generally accepted principles of classification in such areas as computing technology and technical cybernetics. The proposed classification is illustrated by a block diagram, the units of which are explained. The classification of general-purpose digital transfer systems is discussed in particular. Complex problems of classification in the area of information transfer systems are in no way settled by the opinions presented in the present work which in addition are not unique possibilities. The material presented in the paper can be used by interested specialists both for further consideration and in day-to-day work with respect to the construction of the structure of contemporary communication techniques. Figures 2; references: 6 Russian. [72-6415]

## STUDY OF THE STABILITY OF ONE ALGORITHM FOR THE FILTERING OF A PSEUDORANDOM SIGNAL UNDER THE INFLUENCE OF SIMILAR SHIFTING NOISE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1629-1638 manuscript received 5 Dec 78

PONOMARENKO, V. P.

[Abstract] The solution to the problem of creating an optimal algorithm for the filtering of broadband pseudorandom phase-manipulated signals for an extensive class of cases when the processes of a change in the information parameters of the signal, i.e., in the phase,  $\Theta(t)$ , and delay,  $T(t)$ , are simulated respectively by Wiener and Gauss exponentially correlated random processes results in the following equations for estimates of parameters  $\Theta$  and  $T$ :  $\Theta^* = [k_1/p][R(T - T^*) \sin(\Theta - \Theta^*) + n_1(t)]$  and  $T^* - \tau_0 = [k_2/(1 + T_1 p)][D(T - T^*) \cos(\Theta - \Theta^*) + n_2(t)]$ . Here  $p \equiv d/dt$ ,  $R(T - T^*)$  is the autocorrelation function of the signal,  $D(T - T^*)$  is a nonlinear characteristic determined by the error formation algorithm,  $\epsilon = T - T^*$ ,  $\tau_0$  is the known constant value of delay  $T$ .  $T_1$  is the time constant,  $k_1$  and  $k_2$  are parameters, and  $n_1(t)$  and  $n_2(t)$  are the noise components of the signal. This algorithm is implemented by means of a two-loop follow system with cross feedback consisting of a filterless automatic phase control system and an inertial static delay following



system with an integrating filter of the first order. A study is made here of the stability of a two-loop synchronization system implementing the optimal algorithm for the filtering of a pseudorandom radio signal under the effect of similar shifting noise. The problem is discussed, of protection from deliberate imitating noise designed to distort the useful information and to render impossible automatic following of the signal's parameters. In particular, a shifting broadband pseudorandom signal is discussed, which is similar to the useful signal but differs from it in amplitude, in the difference from the carrier frequency and by a time shift which changes monotonically over time. The problem of estimating the stability of the algorithm given above in relation to the similar interference described is discussed. Stability here means the ability of this algorithm to maintain its characteristics over a certain range with a change in the parameters of the interference, i.e., its strength and frequency and time difference. The stability of this algorithm depends on whether the system is in a state of synchronism at the instant of arrival of the noise. The results are given of a study of the stability of the algorithm under the effect of similar shifting noise arrived at by studying the conditions for the functioning of this algorithm and by determining the limits for the maintenance and collapse of parameter following in the system and the capture limits. A mathematical model is presented for the system, steady-state conditions are discussed and the stability is discussed of the algorithm under the influence of interference on the captured system and with the simultaneous influence of the signal and interference. It is demonstrated that under conditions of the effect of similar noise the stability of this algorithm can be estimated in terms of the size of the domain for the maintenance of the follow principle and from the size of the domain of capture. In the absence of noise the stability of the algorithm can be evaluated in terms of the domain of values of parameters. The quantitative results derived here for all three of these domains make it possible to estimate the influence of the parameters of the system and of the interference on the stability of the algorithm. Figures 6; references: 9 Russian. [44-8831]

UDC 621.391.2

# NOISE IMMUNITY ESTIMATES (LINEAR WITH RESPECT TO ORDER STATISTICS) OF INTENSITY OF NOISE SIGNAL

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1996-1999  
manuscript received 25 Dec 78

DANILOV, V. I.

[Abstract] This brief communication is concerned with the construction and analysis of the quality of estimates of the intensity  $\theta_c$  of a noise signal, with the aid of the totality of first order statistics in samples of some fixed volume  $n$ . The algorithms considered here, together with their use in radiometry, can find use in problems of self-selection, and also during processing of radar information in non-stationary noise. Figures 1; tables 1; references 4: 3 Russian, 1 Western. [68-6415]

## ON DESIGNING CORRELOMETERS WITH CORRELATION FEEDBACKS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2239-2241  
manuscript received 26 Apr 79

GOLIKOV, V. S.

[Abstract] For optimum signal processing in the presence of additive normal steady correlation interference when the nature of signal and interference is a priori unknown, correlation circuits that are optimum in the sense of producing a reference signal with maximum signal-to-interference ratio must be capable of real-time operation as information on the signal and interference arrives. The authors consider the equation for optimum correlation processing and develop algorithms for getting the optimum correlation function in systems with correlation feedbacks for any delay times. The corresponding correlometers are described. Figures 1; references: 5 Russian.  
[80-6610]

## USING ORTHOGONAL FILTERS IN CORRELOMETERS WITH CORRELATION FEEDBACKS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2241-2243  
manuscript received 26 Apr 79

GOLIKOV, V. S. and DOVENYA, B. A.

[Abstract] When processing signals in the presence of normal correlated interference and noise, recurrence algorithms can be used in order to obtain a correlation function that is optimum in the sense of maximizing the signal-to-interference ratio. One of the ways to realize such algorithms is by using orthogonal filters. An expression is derived for the voltage at the output of an orthogonal filter with given pulse response when the input is a signal mixed with interference and noise, and formulas are given that describe the principle of design of an optimum correlometer based on orthogonal filters. A block diagram of such a correlometer is given. Figures 1; references: 2 Russian.  
[80-6610]

## STUDY OF THE EFFECTIVENESS OF THE DIGITAL ADAPTIVE GRADIENT METHOD OF NOISE SUPPRESSION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1774-1776  
manuscript received 12 Feb 79

ABRAMOVICH, Yu. I. and DANILOV, B. G.

[Abstract] The optimal solution to the familiar problem of maximizing the signal-to-noise ratio is represented as  $W_{opt} = D^{-1}S$ , where  $D$  is the noise correlation matrix and  $S$  is the "direction" vector determined by the direction of the arrival of the useful signal. Estimates have been made of the influence on the effectiveness of noise suppression of a finite number of levels for a digital representation of this solution. These estimates were arrived at as the result of digitizing a precise solution to this equation. The question is discussed here of whether these estimates can be applied to adaptive gradient procedures with a finite word length of operations at each step. A study is made of the influence on the effectiveness of noise suppression of a finite word length of the optimized vector by discussing simplified models of the digital adaptive gradient algorithm. For the sake of comparison a study was also made of the determinate gradient procedure in which the correlation matrix,  $D$ , per se is used instead of the stochastic analogue. Modeling was performed five times for each number of quantization levels. It is demonstrated that the effectiveness of procedures depends only slightly on the specific method of realizing the digital gradient algorithm. The results of modeling the algorithm are given for a 10-element antenna array with two instances of interference acting in the direction of the maxima of the first two side lobes. Averaged curves are given illustrating the dependence of the amount of noise suppression on the number of quantization levels. Suppression of 45 to 50 dB is realized with a number of quantization levels of  $K = 11$  bits, 30 to 35 dB with 6 bits and 10 to 15 dB with 3 bits. A comparison of the results arrived at with the original estimates mentioned above makes it possible to conclude that for the purpose of achieving the required effectiveness of noise suppression the stochastic gradient method requires no shorter a word length than in quantizing the optimal solution. It is therefore possible to use the original estimates as bottom estimates of possible losses resulting from the finite arithmetic for the stochastic gradient method. It is also demonstrated that the stochastic procedure is considerably more effective than the original determinate procedure with all values of  $K \leq 11$  bits considered. For the case of determinate gradient procedures a finite word length results in more serious losses in the absence of a stochastic linearization effect. Figures 4; references 4: 3 Russian, 1 Western. [44-8831]

## ON THE SEPARATION OF AN X-RAY SIGNAL AGAINST A BACKGROUND OF NOISE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 2001-2004  
manuscript received 5 Feb 79

GERCHIKOV, F. L.

[Abstract] Separation of an x-ray signal against a background noise is investigated. A block diagram is presented of the x-ray system employed, which consists of a controlled pulse x-ray generator radiating in the direction of the reflecting surface of the flow of energy, a scintillation counter which records the flow of emission backscattering, and a unit for information processing which generates a signal, proportional to the amplitude or time of propagation of the backscattering of the x-ray signal. It is shown that passage of the pulse x-ray signal into an air environment is accompanied by backscattering noise from the air which is determined by the energy of the x-ray quanta and the geometrical parameters of the system. With a correct choice of the last-mentioned, backscattering noise can be localized in time and fixed in amplitude (with the statistical nature of the x-ray signal taken into account). Space-time correlation of the information signal and the noise is followed. It is shown that with an increase of the distance to the reflector, the signal at the input of the scintillation counter lags behind the relative noise for a strictly determined length of time. The proposed schemes for noise compensation make it possible substantially to increase the range of functioning of the x-ray control system. Figures 2; references 12: 11 Russian, 1 Western.  
[68-6415]

## DECODING OF MAJORITY-MULTIPLEXED SIGNALS WITH THE AID OF DIADIC CONVOLUTION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1999-2001  
manuscript received 22 Jan 79

LOSEV, V. V.

[Abstract] Majority-multiplexed signals are used in many applications. The potential possibilities of these signals are realized during decoding by the method of maximum probability, which consists of a calculation of the correlation of the applications taken with all possible code words. The overall number of elementary operations fulfilled is equal to  $N(N-1) \sim N^2$ , where  $N$  is the length of the signal. Large computing expenditures do not permit use of the method of maximum probability in many real systems. The present short communication shows that it is possible substantially to decrease the volume of computations by means of the use of algorithms of fast transformation. References: 5 Russian.  
[68-6415]

## PROBLEM OF FILTERING UNDER THE CONDITION OF AMBIGUOUS MEASUREMENTS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1881-1887  
manuscript received 8 Dec 78

ROZOV, L. S. and SORISOV, N. V.

[Abstract] At present during solution of the problem of filtering, it is most commonly assumed without reservation that the measurable magnitudes are counted off identically. However, in practice this assumption is not always fulfilled. In particular, in radar with the use of package signals, and phase method of measurement of certain coordinates, the observed objects are measured (e.g., by the phase method) ambiguously. Here, consideration is given to the problem of filtering under the above conditions. A solution is found for the problem of integral quadratic programming. In the absence of ambiguous measurements a formula from the present paper degenerates into a constant and another formula passes to a widely known expression for evaluation of the vector  $\theta$  with Kalman filtering. The probability of anomalous error is discussed. In the case of one ambiguous measurable magnitude, the resultant problem of integral programming is solved analytically. References 7: 5 Russian, 2 Western.  
[68-6415]

## ON THE ASYMPTOTIC EFFICIENCY OF ADAPTIVE LINEAR FILTERING OF RANDOM SIGNAL ACCORDING TO THE SIGNAL-TO-NOISE RATIO MAXIMUM

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 2009-2011  
manuscript received 11 May 79

BASHIN, G. M. and DMITRIYENKO, A. N.

[Abstract] In a general form the problem of synthesis of an optimum digital linear filter with a finite memory, which maximizes the signal-to-noise ratio normalized to the input with respect to the power for stationary normally distributed values with zero average of actual vector samples of an adaptive mixture of signal with noise, was solved in a 1972 paper of which Bashin was a coauthor. In the present short communication it is shown that with a wideband uncorrelated signal, the pulse response of an optimum filter which maximizes the noise suppression coefficient  $\eta$  coincides with the latent vector  $Z^{(k)}$  of the correlation noise matrix  $M$ . The asymptotic relative losses of the magnitude of the maximum noise suppression coefficient is investigated during synthesis of an optimum filter according to a known unbiased evaluation of the matrix  $M$ . Values are presented which make it possible to evaluate the relative losses for any amount of vector samples of noise (with correctness of approximation). Tables 1; references: 3 Russian.  
[68-6415]



# CONCERNING REQUIREMENTS FOR ACCURACY OF SYNCHRONIZATION IN DATA TRANSMISSION BY AN OPTICAL PULSE-POSITION MODULATED SIGNAL

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2235-2238  
manuscript received 22 Jun 79

GOL'DSHTEYN, Yu. A. and FREZINSKIY, B. Ya.

[Abstract] The authors consider the problem of clock synchronization in data transmission as a statistical problem in estimating the a priori unknown position of the boundaries of pulses. In the case of optical pulse-position modulated signals, decoding is based on knowledge of the initial readout position, and clock synchronization involves determination of both the initial position  $l_0$  and the displacement  $x$  of the pulses relative to a priori time marks. A simplified algorithm is considered in which the quantities  $x_0$  and  $l_0$  are determined by processing only the synchronizing pulses with comparison of  $k$  matrices  $k = (\tau/\Delta x)$ , where  $\Delta x$  is the fixed step of change in  $x$ ,  $\tau$  is duration of the synchronizing pulses and the brackets indicate the integer part of the number. It is shown that requirements for the synchronization system can be substantiated properly with permissible error probability only when available energy resources are taken into consideration. The greater the energy resources, the greater will be the effect of optimum synchronization. At low energies, synchronization does not improve the probability of correct reception. In all cases an overstatement of requirements for the synchronization system will be detrimental to the reliability of data reception in the final analysis. Figures 3; references: 2 Russian.  
[80-6610]

# ON ONE POSSIBLE SOURCE OF NOISE IN RADIOELECTRONIC EQUIPMENT

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 2016-2017 manuscript received 7 May 79

KUTIKOV, A. V., SOROKIN, V. M. and FEDOROVICH, G. V.

[Abstract] In the course of tests on an interference suppressing precision amplifier, some connections in which were made for structural reasons with steel conductors, it was found that in a comparatively slowly changing (with a frequency of 50 Hz) magnetic field in an amplifier circuit, stray currents of the white noise type originate, the characteristic frequency of which lies in the  $\sim 10$ -100 kHz region. The reason for this is a random emf which originates in steel conductors in a slowly changing magnetic field. An installation, the block diagram of which is shown, was assembled for an investigation of the characteristics of the above phenomena.

An observation was made of a random emf in a variable magnetic field. The results of the observations conducted show the necessity for taking account of the possibility of formation of a random emf in ferromagnetic materials placed in a slowly changing magnetic field during construction of precision electronic devices. Figures 2; references: 2 Russian.  
[68-6415]

UDC 621.391.833

#### DISCRETE FILTRATION OF PIECEWISE-CONSTANT SIGNALS

Leningrad IZV. VUZ: PRIBOROSTROYENIYE in Russian Vol 23, No 9, Sep 80 pp 3-7 manuscript received 20 Nov 79

CHURAKOV, Ye. P. and FAT'YANOV, S. O.

[Abstract] A method is proposed for discrete filtration of piecewise-constant signals from Gaussian noise with a smaller error than that of the averaging method. The length of the observation time is changed automatically as a direct function of the mean-square deviation of the process estimate from the input data. If the process observed at discrete instants of time  $t_1$  is  $v_1 = v(t_1) = x_1 + p_1$ , where  $x_1$ 's constitute the piecewise-constant useful signal with a priori not predicted transitions from one unknown state to another and  $p_1$ 's  $\in N(0, \sigma^2)$  are the measurement errors, then  $\hat{x}_{j,n}$  will denote the estimate of process  $x(t)$  at instant of time  $t_n$  based on observations,  $v_j, v_{j+1}, \dots, v_n$ . If process  $x(t)$  does not change during the interval of time  $t_j - t_n$  and if the measurement errors are uncorrelated, then estimate  $\hat{x}_{j,n}$  can be expressed in a recurrence form. The algorithm is easily programmable on a digital computer for immediate processing of input data. The disadvantage of a large memory capacity for storing a large data volume before the observation time can be shortened, is offset by the advantage of a very high accuracy. The algorithm has been implemented on a "Nairi" computer as well as on a Unified System YeS-1022 computer. The paper was recommended by the Department (Kafedra) of Automation and Telemechanics, Ryazan' Institute of Radio Engineering. Figures 3; tables 2.  
[71-2415]

## SOME MODELS OF THE ORGANIZATION OF THE TECHNICAL MAINTENANCE OF A CITY TELEPHONE NETWORK

Moscow ELEKTROSVYAZ' in Russian No 9, 1980 pp 38-42 manuscript received 13 Dec 79

VASIL'YEV, V. F. and MATLIN, G. M.

[Abstract] The choice is considered of the optimum method of technical maintenance on city telephone networks (CTN). Three methods of operation exist: technical servicing of equipment is conducted prior to the appearance of failures (prevention method), at the moment of appearance of failures (prevention method), and after the appearance of failures (statistical method). The statistical method of operation involves the creation of centers for technical maintenance, the successful functioning of which depends on the makeup and volume of information concerning breakdowns incoming from the CTN. It is shown that introduction of the statistical method of operation, which is now taking place at a number of CTN, is undoubtedly a progressive measure. However, with its use it is necessary to take into account the reliability of equipment and the parameters of the restoration system because, in the case of certain conditions outlined in the paper, this method can also prove to be noneffective. Additional investigations (for the most part statistical) are concerned with a problem concerning the optimum volume of information on the condition of CTS equipment, the solution of which makes it possible to justify the optimum structure of a hardware complex which assures normal work of the system of technical maintenance. Figures 5; tables 1; references: 1 Russian. [72-6415]

## METHOD OF ESTIMATION OF THE INTERFACE FOR TELEPHONE STATIONS WITH PROGRAM CONTROL

Moscow ELEKTROSVYAZ' in Russian No 9, 1980 pp 34-38 manuscript received 2 Jan 79

DEDOBORSKH, V. G., LUPANIN, V. P. and RYKOVA, M. M.

[Abstract] Formulas are presented for estimating the effectiveness of various methods of organization of an interface between the central control device (TsUU) and the peripheral control device (PUU) of a telephone station with program control. The formulas obtained make it possible in practice to determine the effectiveness of systems of exchange between TsUU and PUU for various methods of its organization (radial, main line, radial-tandem and radial-main line) and to select the optimum structure of such a system for a specified capacity of the telephone station. Formula (6) in the paper makes it possible to determine the effectiveness of functioning of systems of exchange between TsUU and PUU for any structure and any number of

ranks. It is possible to determine with the aid of formula (7) the effectiveness of functioning of a completely doubled system of exchange. Figures 4; references: 3 Russian.  
[72-6415]

UDC 621.395.6.019.3

#### SOME PROBLEMS OF THE RELIABILITY OF JUNCTION POINTS, STATIONS, AND CLUSTERS OF CHANNELS OF SWITCHED NETWORKS

Moscow ELEKTROSVYAZ' in Russian No 9, 1980 pp 29-34 manuscript received 20 Mar 78

SUTORIKHIN, N. B.

[Abstract] The absence of a single terminology and a single system of reliable indices for junction points, stations, and clusters of channels to a considerable degree complicates the solution of the problem of increasing the reliability of equipment for the state communication network. During formulation of the principal concepts and assessments, as well as during development of indices for evaluation of the above units, it is necessary to take into consideration the special features of those in operation as well as prospective switching units and stations, and also the equipment of multichannel transfer systems on the base of which clusters of channels in the directions of communication are organized. Concepts and assessments of the reliability of switching units, stations and clusters of channels are considered. Methods of assuring reliability of equipment are shown, the creation of norms for reliability indices is discussed, and an example of determining scientifically valid norms for several reliability indices of the centralized equipment of a municipal automated telephone station is presented. Figures 2; references 14: 10 Russian, 4 Western.  
[72-6415]

## KURS-2M RADIO RELAY EQUIPMENT

Moscow ELEKTROSVYAZ' in Russian No 9, 1980 pp 9-13 manuscript received 9 Apr 80

POBORCHIY, Ye. D.

[Abstract] Basic data are presented on the 1700-2100 MHz KURS-2M radio relay system which enters into a complex of unified radio relay systems (KURS) and is intended for zone communication lines. The special features of the system are discussed. The input high-Q circuits of the receiver and the output circuits of the transmitter are fulfilled on the basis of balanced transmission strip lines with a circular interior conductor and air dielectric. The receiving device substantially differs from the microwave receivers of other KURS systems because of the use of a narrow-band mixer with low conversion losses. The transmitting installation does not have a microwave amplifier at the output. The units of the KURS-2M equipment have increased technological effectiveness of manufacture. Figures 6; tables 1; references 4: 3 Russian, 1 Western.  
[72-6415]

## PERMISSIBLE IRREGULARITY OF GROUP DELAY TIME OF HIGH-FREQUENCY RADIO TRUNK DURING TRANSMISSION OF SOUND ACCOMPANIMENT ON SUBCARRIER

Moscow ELEKTROSVYAZ' in Russian No 9, 1980 pp 14-20 manuscript received 28 Jul 79

SMANTSER, A. N. and SHENDEROVICH, A. M.

[Abstract] Consideration is given to the mechanism for formation of transient noise with a frequency of 7.812 kHz in the sound channels arranged on subcarriers, during transmission of signals of the SEKAM television system. Equations are derived and evaluated which determine the principle of summation of transient noise. With the object of developing a norm for the magnitude of the phase distortions in the high-frequency channel with a mistuning of 11-13 MHz, measurements were made of the noise of the type under consideration with known phase distortion of the high-frequency channel. Rating of the permissible distortions of the phase-frequency characteristic at the edge of the band of the high-frequency channel is conducted. It is concluded that the high-frequency channel of the trunk radio relay line with frequency modulation which is intended for transmission of the color TV of the SEKAM system must be corrected in the frequency band  $70 \pm 13$  MHz. It is impossible to use irregularity of the group delay time (GVZ) as a criteria for the adequacy of the correction. Figures 8; tables 2; references 6: 5 Russian, 1 Western.  
[72-6415]



## APPROXIMATE ANALYSIS OF ATMOSPHERIC MODULATION NOISE IN AN OPTICAL HETERODYNE RECEIVER

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2223-2227  
manuscript received 10 Aug 79

OBUKHOV, I. V.

[Abstract] The problem is considered of distortions introduced by the turbulent atmosphere into the complex envelope of the i-f photocurrent of an optical heterodyne receiver. Simple formulas are derived for the correlation function and spectrum of modulation noise in the case of a circular aperture of given radius when the radiation incident on the receiving lens passes through a turbulent layer with inhomogeneities that move with a given velocity across the direction of wave propagation. Comparison with exact calculations shows that the proposed formulas give a satisfactory approximation over the entire range of dimensions of reception apertures. Figures 5; references 6: 5 Russian, 1 Western.  
[80-6610]

## OPTIMIZATION OF SIGNALS FOR RAPID RECEIVER SYNCHRONIZATION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2146-2154  
manuscript received 28 Jun 79

TUZOV, G. I.

[Abstract] In electronic systems that use complex signals, initial synchronization (search) is handled by determining the phase (delay) of a binary periodic sequence. In the general case, delay is determined by the signal base  $L$ , and may be excessive for large  $L$  and when there are limitations on the number of correlators of the search system. Signals that enable using the method of dichotomy can shorten the overall search time. However, such synchrosignals have a large number of components that are not completely utilized in search, which is disadvantageous from the energy standpoint, and electromagnetic compatibility with the simplest signals is poor. To avoid these difficulties, the author proposes an optimized synchrosignal that is the sum of pseudorandom signals with various clock frequencies. To ensure rapid lock-in with respect to delay of such a signal, a correlation-estimate principle is developed for filtration, using a method of successive approximations starting with low-frequency terms and proceeding to higher frequencies. An examination is made of the advantages of the proposed technique over the method of dichotomy. Figures 4; references: 8 Russian.  
[80-6610]

# MEANS OF GROWTH AND IMPROVEMENT OF NETWORKS FOR TELEGRAPHIC COMMUNICATION AND DATA TRANSFER

Moscow AVTOMATIKA, TELEMEXHANIKA I SVYAZ' No 1, May 80 pp 4-7

SAKHIN, A. A., chief of Central Communication Station, Ministry of the Communications Equipment Industry, candidate of technical sciences, and BORTSOV, D. V., senior engineer

[Abstract] The means of growth and improvement of railroad transport networks for telegraphic communication and data transfer are considered under the following headings: 1) Growth of networks; 2) Means of improvement of networks; 3) Nonproductive load of a telegraphic network; 4) Improvement of switching equipment of network; and 5) Improvement of systems of channel-forming equipment. The development of a general system of growth of networks of telegraph exchanges, direct interconnections and data transfer (AT-PS-PD) is also considered, and control and measuring techniques for such networks are described. It is proposed to improve terminal telegraphic equipment by substitution of certain apparatus. For the period 1966-79, the number of discrete channels on the railroad network for telegraphic communication and data transfer increased 3.5 times and on the average the volume of discrete information increased during this same period by 80%. During the 1966-1979 period the volume of transit telegrams was decreased from 60 to 10% of the overall volume of the telegraphic load at intermediate junction points. When published the second part of this paper will consider means of improvement of the control systems of an AT-PS-PD network. Figures 1.

[67-6415]

# TO AN INSPECTION OF NORM DOCUMENTS CONCERNED WITH PROTECTION OF COMMUNICATION STRUCTURES FROM THE EFFECT OF ELECTRICAL FIELDS

Moscow AVTOMATIKA, TELEMEXHANIKA I SVYAZ' No 1, May 80 pp 28-29

CORILOVSKIY, M. I., chief project engineer of "Kievgioprotrans" Institute

[Abstract] Long-time experience by the "Kievgioprotrans" Institute in fulfilling a large volume of work on the planning of railroad electrification and the cable communications lines for them has shown the presence of a number of significant shortcomings in the active norm documents for planning the protection of communication structures from the effect of electrical transmission lines and traction networks. These shortcomings are discussed in the present paper.

[67-6415]

COMPONENTS AND CIRCUIT ELEMENTS, WAVEGUIDES,  
CAVITY RESONATORS AND FILTERS

UDC 621.317.32

A COMPARATOR WITH CORRECTION

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 116-118  
manuscript received 6 Feb 79

ZHUKOV, A. V. and MAKHOV, V. N., Ural Polytechnical Institute, Sverdlovsk

[Abstract] In cases where it is necessary to determine the sign of a rapidly changing voltage against a background of slowly changing (drifting) voltage, a comparator can be used with correction of the drift at the instants when the rapidly changing voltage is zero. Such a device is described in which correction reduces the error component caused by temperature drift of the bias voltage almost to zero. The sensitivity of the comparator is 25  $\mu$ V over an input signal range of  $\pm 10$  V. The device has high input impedance, and ECL and TTL output levels. Operating speed is no slower than 100 ns. Figures 2; references: 3 Russian.  
[62-6610]

UDC 621.372.8.049.75

ALGORITHM AND RESULTS OF ELECTRODYNAMIC ANALYSIS OF AN ASYMMETRIC STRIPLINE

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 73-75 manuscript received 4 Apr 79, after revision 23 Nov 79

POSTNIKOV, V. F., ROMANOV, V. P. and GERASIMOVA, O. N.

[Abstract] Algorithmization of stripline equations for computer solution leads to an analysis of algebraic equations with coefficients (matrix elements) that are usually slowly converging series. Therefore to get acceptable accuracy it is either necessary to retain up to 50 terms of these series or to resort to complex analytical methods of summation. In this paper a method of algorithmization is considered that leads to solution of algebraic equations with simple single-term elements. The algorithm is based on numerical solution of canonical equations (Kirchhoff-Fourier equations) that show the relations between complex amplitudes of spatial vector harmonics of the electric field and current density in the plane of the strips. Figures 1; tables 1; references 4: 3 Russian, 1 Western.  
[64-6610]

## DISPERSION CHARACTERISTICS OF SLOT-COUPLED STRIPLINES

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 10-16 manuscript received 25 Sep 79

LERER, A. M. and TSVETKOVSKAYA, S. M.

[Abstract] The Galerkin method is used to calculate the characteristic parameters of striplines coupled through a longitudinal slot in the common grounded wall with consideration of the dispersion of electromagnetic waves. Odd and even modes of the waveforms in such a stripline are considered separately. In the case of odd excitation, an electric wall is placed in the plane of the slot, and the solution reduces to consideration of a single stripline. In the case of even excitation, a magnetic wall is located in the plane of the slot, and a special structure must be analyzed. An algorithm is found for solving the problem, and a program is compiled for the BESM-6 computer. Figures 3; references 6: 5 Russian, 1 Western. [64-6610]

## APPLICATION OF THE METHOD OF STATISTICAL TESTS TO CALCULATION OF STRIPLINES IN THE T-APPROXIMATION

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 17-22 manuscript received 22 May 79

MISHUSTIN, B. A., SADOVSKIY, N. V. and SITNYANSKIY, B. D.

[Abstract] A Monte Carlo method is applied to solution of the Laplace equation and probabilistic approximation of the parameters of shielded microstrips with dielectric backing with consideration of the finite thickness of the strip at different distances from the shield. It is shown that statistical sampling methods can yield compact high-speed programs for determining the parameters of striplines with complex cross-section shape. The results are in good agreement with experimental data cited in the literature. Application of the proposed technique to calculation of stripline parameters is limited by the assumption of a zero fundamental longitudinal component of electric and magnetic field strengths in the wave (T-approximation). In the low-frequency part of the microwave band this approximation is completely applicable, but loses validity at frequencies above 10 GHz for real striplines. Figures 2; tables 2; references: 8 Russian. [64-6610]

## BOUNDARY DIMENSION OF A DIELECTRIC STRIPLINE

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 81-83 manuscript received 10 Apr 79, after revision 3 Dec 79

MEL'NIKOV, A. V.

[Abstract] Methods of analysis and simple expressions have been proposed for determining the constants of propagation of a dielectric stripline that contains a rectangular dielectric waveguide immersed in a dielectric substrate of a material with a smaller index of refraction. However, these expressions are valid for the region far from cutoff. This makes them inapplicable to analysis of the critical conditions of a dielectric stripline and determination of such important characteristics as boundary dimensions and the cutoff frequency of waveguide modes. The author considers the problem of determining the boundary dimensions and the bandwidth properties of dielectric striplines. The analysis is based on the approximate model of E. A. J. Marcatili [BSTJ, Vol 48, No 7, 1969, pp 20/1-2102]. The derived expressions were used to calculate the boundary dimensions of a waveguide for various modes of a stripline formed by a polyethylene waveguide immersed in a Teflon substrate. The results were experimentally verified in the shortwave part of the millimeter wave band. Figures 3; references 5: 3 Russian, 2 Western (1 in translation).

[64-6610]

## CALCULATION OF THE PARAMETERS OF AN EVANESCENT DIELECTRIC WAVEGUIDE RESONATOR

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 43-48 manuscript received 18 Apr 79

BERGER, N. M., KAPILEVICH, B. Yu. and SIMIN, N. S.

[Abstract] A theoretical and experimental analysis is made of the major parameters (resonant frequencies, loaded and unloaded Q) of a rectangular evanescent resonator with a flat dielectric layer. An investigation is made of the influence that electrical and physical factors have on these parameters. Experimental data are compared with the theoretical results for resonant frequencies of a waveguide with a cross section of 11 x 5.5 mm in the 8-12 GHz band with a dielectric layer of quartz glass. The results are within 2-3% of theory. Experimental and theoretical data also agree satisfactorily for initial losses as a function of passband. The resonant frequency of an evanescent waveguide section with symmetrically placed flat dielectric layer is determined by the dimensions and permittivity of the dielectric material and the width of the evanescent waveguide. The width of the resonance peak



is determined by the lengths of the evanescent waveguides. Resonant effects are weakened by shifting the dielectric layer from the symmetric position. A resonator of this type may have a Q of 2000-3000 in the centimeter band when dimensions are small. Figures 4; tables 2; references 6: 4 Russian, 2 Western.  
[64-6610]

UDC 621.372.852.1

#### MICROWAVE FILTERS BASED ON AN EXTERNALLY EXCITED DIELECTRIC WAVEGUIDE RESONATOR

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 49-52 manuscript received 28 Jul 79, after revision 17 Dec 79

DVADNENKO, V. Ya., KOROBKIN, V. A. and KHIZHNYAK, S. N.

[Abstract] An analysis is made of microwave filters based on dielectric waveguide resonators with external excitation comprised of a section of rectangular waveguide of a given length completely filled with a dielectric with permittivity such that an  $H_{30}$  working wave can propagate in this section. At a given distance on both sides of this dielectric filler are symmetric mode-converting inhomogeneities. In one type of filter these are inductive metal rods, and in another type they are resonant metal rods tuned to the working frequency of the waveguide resonator. The characteristics of such filters are compared with devices based on hollow waveguides and dielectric resonators. It is found that externally excited dielectric waveguide resonators have higher frequency selectivity per resonator at the same bandwidth. Minimum losses for a sapphire dielectric are comparable to those of filters based on hollow waveguides. They are also considerably shorter than filters based on hollow waveguides. The described filters have higher working power and better thermal stability than those based on dielectric resonators. Figures 3; references: 5 Russian.  
[64-6610]

## ELECTRICAL SWITCHING OF THE PHASE OF A SHUNTED SIGNAL BY A CONTROLLED DIRECTIONAL SYSTEM BASED ON COUPLED WAVEGUIDES

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 3-9 manuscript received 11 Jun 79

AL'TSHULER, Yu. G. and USOV, N. Yu.

[Abstract] An investigation is made of the feasibility of phase control by a wide-band directional waveguide coupling system designed for electrical switching of the phase of a signal shunted into an auxiliary channel. The phase is discretely switched by directional couplers with electrically controlled transient attenuation. The coupling zone of each waveguide is formed by special wide-band loop waveguide coupling components containing longitudinally distributed PIN structures. The investigated directional coupling system contains two identical directional couplers with electrically controlled transient attenuation. Part of the power from the main channel is transmitted through the coupling zones of these couplers into the auxiliary channel. Between coupling zones in the auxiliary channel is a phase-shifting device. When the input signal is fed into the main channel and one of the coupling zones is blocked, the phase of the signal at the output of the main channel is determined by the length of the channel, while the phase of the signal at the output of the auxiliary channel can be electrically switched by blocking one of the coupling zones. A section of rectangular waveguide with a dielectric plate parallel to the narrow wall was used as the phase shifter. The plate completely filled the waveguide section heightwise, and could be moved in the transverse direction to control phase shift. Phase switches of the proposed type can be used in systems for controlling phased antenna arrays and in measuring equipment. Figures 6; references 8: 6 Russian, 2 Western.  
[64-6610]

## A SPARK GAP WITH HIGH PULSE REPETITION RATE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 89-90 manuscript received 23 Feb 79

MALYUTA, D. D. and MEZHEV, V. S.

[Abstract] A spark gap with recurrence rate of up to 4 kHz is described for commutation of a CO<sub>2</sub> laser with supersonic gas flow. The device is coaxial in design with copper electrodes having porous copper-impregnated tungsten tips separated by a ceramic diaphragm with a center hole. The gap operates in the quasi-steady state on a cycle of about 0.5 s. Nitrogen is fed into the discharge gap. Supply is from

a capacitor bank, and the amplitude of the trigger pulses is 20-40 kV with duration of about 1  $\mu$ s. The duration of current pulses through the load is 0.1-1  $\mu$ s at an amplitude of 1-5 kA. The device has low inductance, which is important for commutation of excimer pulse lasers. Measurements of gap recovery time show that in principle the proposed device could operate at a pulse recurrence rate of about 10 kHz. The authors thank Yu. B. Smakovskiy and A. P. Strel'tsov for constructive criticism and practical assistance. Figures 1; references: 3 Russian. [62-6610]

UDC 621.396.67.095

#### SCATTERING LOSSES IN AN IRREGULAR ASYMMETRIC DIELECTRIC WAVEGUIDE

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 38-42 manuscript received 16 Jul 79

GIL'YERMO, Andler and CHEREMINSKIN, I. V.

[Abstract] The method proposed by D. Markudze ["Optical Waveguides," Mir Publishers, Moscow, 1974] is applied to determination of the power dissipated by an incident waveguide mode propagating through a waveguide section with irregular boundaries between the carrier layer and bordering media into other waveguide modes and emission modes. The analysis applies to a flat asymmetric waveguide of infinite extent along the y-axis where there is no field variation. Deviations from the plane of the irregular waveguide in the direction of the x-axis are minor. Formulas are derived for the relations between attenuation factors, waveguide parameters, the correlation interval and the rms deviation of the walls of the waveguide from rectilinear. Figures 3; references: 2 Western(in translation). [64-6610]

## DETERMINATION OF THE POLARIZATION STATE OF AN ELECTROMAGNETIC WAVE

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 23-26 manuscript received 29 Jun 79

YURKOV, N. K.

[Abstract] A theoretical analysis is made of the physical effect responsible for operation of a microwave phase shifter in which the signal phase shift is controlled by interaction with a higher mode excited in the same waveguide. A special diffraction converter is used to produce the parasitic higher mode. Operation of the phase shifter is analyzed on the basis of its scattering matrix. For this purpose, the device is represented as cascaded equivalent networks. The effort described has been used in a microwave phase shifter that eliminates conversion signal losses. Change in the polarization state of such a system is practically instantaneous when controlling the phase mismatch of signals of orthogonal channels. Figures 2; references 5: 4 Russian, 1 Western.  
[64-6610]

## HIGH-SPEED COMPARATOR WITH BISTABLE CELL

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 113-115 manuscript received 12 Dec 78

BAKINOVSKIY, K. N. and SHCHORS, L. S., Scientific Research Institute of Applied Physics Problems Affiliated with Belorussian State University, Minsk

[Abstract] A comparator is proposed that is based on a K500TM30 integrated circuit (two D flip-flops in a single housing). The regenerative part of the device uses only the positive feedback produced by external connection of the D input to the noninverting output. Speed was increased to 100 MHz by reducing the decision making time. This is done by transferring the result of comparison to a supplementary D flip-flop somewhat prior to formation of the logic differential at the output of the comparator. Aperture is 0.5 ns. The proposed comparator is an improvement over devices based on the 1TR381 IC in nearly all respects. Figures 3; references: 5 Russian.  
[62-6610]

## EXCITATION OF A FOCUSING FIBER BY A LAMBERT SOURCE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2233-2234  
manuscript received 20 Aug 79

SOKOLOVSKIY, A. A. and SHATROV, A. D.

[Abstract] The authors consider the problem of Lambert-source excitation of a multi-mode optical fiber with square-law gradient of the index of refraction. The emitting surface of the source is a circle of radius  $b$ . The fiber is characterized by numerical aperture  $\theta_0$ , and radius  $a_0$  of the light-guide strand. The source and end face of the fiber are coaxial and separated by an air gap of width  $z$ . Assuming  $\theta_0 \ll 1$ , an analytical expression is found for matching efficiency as a function of parameters,  $\theta_0$ ,  $b$ ,  $z$ ,  $a_0$ , considering only the power captured by surface modes. Curves are given showing the results of calculation of the efficiency of excitation of a focusing fiber as a function of the gap  $z/a_0$  for different values of  $b/a_0$ . The calculations agree with the results of computer modeling and experimental data. Figures 1; references 3: 1 Russian, 2 Western.  
[80-6610]

## APPLICATION OF THE GALERKIN METHOD FOR COMPUTATION AND INVESTIGATION OF THE CURRENT DISTRIBUTIONS OF THE FUNDAMENTAL AND HIGHER-ORDER NORMAL MODES OF AN ASYMMETRICAL STRIP LINE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1844-1850  
manuscript received 9 Apr 79

IL'INSKIY, A. S. and ZARUBANOV, V. V.

[Abstract] A numerical method is presented for locating the currents of fundamental and higher-order nonradiating waves of an asymmetrical strip line over a wide band of frequencies. An algorithm which resists computational errors is described. A system of functional equations of the I order for the Fourier transform of longitudinal and transverse currents is obtained from the condition of equality to zero of the tangential components of the electrical field and is solved by the Galerkin method. In order to obtain distribution of currents, it is necessary with a found value of constant propagation to discover a neutral solution of a uniform system. A program is formulated, composed in FORTRAN language for the "BESM-6" computer. The results make it possible to draw conclusions concerning the effectiveness of the proposed numerical method for calculation of the fields of the characteristic waves of an asymmetrical strip line. It is also possible to use the method discussed for investigations of other types of strip lines. Figures 3; references 11: 7 Russian, 4 Western.  
[68-6415]



## WAVE PROPAGATION IN COMPOSITE GRADIENT-INDEX DIELECTRIC WAVEGUIDES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2228-2231  
manuscript received 6 Apr 79

RUDENOK, I. P.

[Abstract] Requirements for multipurpose waveguide systems in many applications of optoelectronics are met by composite gradient-index waveguides that may contain gradient-index, anisotropic and dielectric layers. The waveguide properties of such systems are described by an exact analytical theory of electromagnetic waves in the simplest gradient-index dielectric structures. The author analyzes wave propagation in a composite gradient-index waveguide in which the relative dielectric constant of the central gradient-index layer varies in accordance with the law  $\epsilon_2(x) = \epsilon(0)(1 - \alpha x^n)$ , where  $\epsilon(0)$  is the dielectric constant in the mid plane,  $\alpha$  is the gradient parameter, and  $n = 2, 4, 10$ . The upper and lower layers have  $\epsilon_1 = \text{const}$  and  $\epsilon_3 = \text{const}$ , respectively;  $\epsilon_3 > \epsilon_1$ , and  $\mu_3 = \mu_1 = \mu_0 = \text{const}$ , where  $\mu_0$  is the permeability of a vacuum. Calculations show that the greatest increments of critical wave numbers are observed for an inhomogeneity described by this law when  $n = 2$ , and the least increment is observed when  $n = 10$  for the same gradient parameter and ratio of the dielectric constant of the outer layers to that in the center of the gradient layer. In such a gradient-index waveguide there is an added increase in the critical wave numbers caused by the inhomogeneity of the central layer over and above that caused by the increase in the number of dielectric layers. The dispersion curve is steepest for  $n = 2$ . When there is no discontinuity of dielectric constant on the interface between the gradient-index and lower ordinary layer, if the gradient parameter is small there is a considerably narrower spread of reduced group delays than that observed in ordinary waveguides. This is particularly true for spatial profiles of dielectric constant with  $n = 2$  and  $n = 4$ . When inhomogeneity of distribution of the dielectric constant is characterized by  $n = 10$ , the spread in group delays is closer to that of an ordinary waveguide. The phase delay shows little change over the entire range of gradient parameters and reduced dimensions of the gradient-index layer. Figures 4; tables 1; references 8: 6 Russian, 2 Western.

[80-6610]

## SCATTERING OF ELECTROMAGNETIC WAVES BY A METAL PLATE IN A RECTANGULAR WAVEGUIDE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2079-2087  
manuscript received 23 Nov 79

GARB, Kh. L., FRIDBERG, P. Sh. and YAKOVER, I. M.

[Abstract] An integral equation is derived for the tangential component of a magnetic field on the surface of an ideally conductive body inserted in an arbitrary space. On the basis of this equation, a steady-state functional is constructed for the impedance of a shunt of an equivalent circuit that describes a metal plate in a rectangular waveguide. This variational functional is calculated by a method proposed by R. F. Fikhmanas and P. Sh. Fridberg [see "Radiotekhnika i elektronika," Vol 23, No 7, 1978, p 1465]. An asymptotic expression for shunt impedance is found in the narrow plate approximation that is also valid for a thin circular rod. The results of numerical calculation are given for the wavelength dependence of impedance. The authors thank A. Masterkov for doing the computer calculations. Figures 4; references 15: 13 Russian, 2 Western(1 in translation).  
[80-6610]

## USING COMBINATIONS OF TRANSMISSION LINES IN MICROELECTRONIC INPUT DEVICES

Kiev IZV. VUZ: RADIOELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 92-94 manuscript received 6 Jul 79

YEFREMOV, Yu. G., NEVGASIMYY, A. F., SKORIK, Ye. T. and SHERMAREVICH, V. G.

[Abstract] Until recently, most microwave microcircuitry has been based on strip-lines. Although microslot, coplanar, microwaveguide and other types of transmission lines have now come into use in some individual microcircuits, the design of multifunctional modules relies as before on striplines because of the lack of a number of devices based on other types of lines. This article describes a set of devices based on different types of transmission lines for constructing a multifunctional receiver with a device best adapted for performance of each specific function. These devices include: a wide bandpass filter, a limiter with wide working frequency band, low-noise amplifier, diplexer with wide signal and i-f bands for a mixer, a junction with low losses in a wide frequency band, a mixer with high decoupling of the signal and heterodyne inputs, and an attenuator with continuous attenuation control over a wide frequency band. The devices are designed around different combinations of microstrip, slot, coplanar and meander transmission lines. Experiments with a multifunctional receiver module show that the proposed approach can give microcircuits with a high degree of integration. Figures 3; tables 1; references 7: 5 Russian, 2 Western.  
[64-6610]

## CONFERENCES, SEMINARS, EXHIBITIONS, SYMPOSIUMS

### SATELLITES AND RADIO RELAY COMMUNICATION AT THE INTERNATIONAL EXHIBITION TELECOM-79

Moscow ELEKTROSVYAZ' in Russian No 9, 1980 pp 51-55

BORODICH, S. V.

[Abstract] Models of the "Intelsat" and "Symphony" and the Soviet satellite "Horizon" were shown at the International Exhibition "Telecom-79," as well as various forms of equipment, apparatus and individual elements used in satellites. A description is given here of some of the earth station apparatus of communication satellites produced by foreign firms. Many firms presented both analog and digital relay apparatus for operation in the frequency band from 2 to 11 GHz. Various source of energy used with radio relay systems were demonstrated. The exhibits at the "Telecom-79" exhibit not only showed the contemporary level of techniques and the technology for production of apparatus, but also the trend of development of satellites and radio relay communications. Figures 5; tables 1.  
[72-6415]

## CONVERTERS, INVERTERS, TRANSDUCERS

UDC 621.382.2:621.372.632.029.65

### INVESTIGATION OF FREQUENCY MULTIPLIER BASED ON A SCHOTTKY BARRIER DIODE IN SHORT-WAVE PART OF MILLIMETER BAND

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 2004-2015  
manuscript received 28 Jun 79

AVERIN, S. V., LYUBHCHENKO, V. Ye., POPOV, V. A. and TSAREV, A. N.

[Abstract] An investigation was made of a frequency multiplier based on the nonlinear resistivity of a Schottky barrier diode. The source of pumping was a Gunn diode oscillator with frequency generation of 62 GHz. The experiment was conducted on a model of a harmonic mixer described in a 1979 paper by S. V. Averin, V. A. Popov and others. A device for spectral investigation with a potential of 68 db was created on the base of a frequency multiplier and a detector based on a Schottky barrier diode with a maximum sensitivity of  $10^{11} \sqrt{\text{W Hz}}$ . Its use as the receiving device of a superheterodyne receiver increases the potential of the system up to ~130 db. In so doing the necessity passes for use of a spectral device for filtration of the harmonics of the multiplier. References 6: 4 Russian, 2 Western.  
[68-6415]

UDC 621.314.1:621.382

### CRITICAL STATES OF RECTIFIER CONVERTERS

Moscow ENERGETIKA I TRANSPORT in Russian No 4, 1980 pp 71-94 manuscript received 17 Apr 78, after revision 4 Oct 79

REPIN, A. M., Moscow

[Abstract] Closed coupling equations are given for the critical parameters of rectifier structures of various classes. These equations are in unified form and have a unified mathematical physics, methodological and terminological basis. The purpose of these equations is to solve the problem of making a direct estimate of the type of mode for specific circuit structures for rectifier power converters. Defined as critical are the various unstable states of circuits which represent a transition from one mode into another. The urgency in solving the problem is caused by the fact that rectifier converters, even with the same circuitry, operate in various modes in relation to their physical state. Characteristic of each are their own

mode-vs.-power characteristics and the results of analyzing and synthesizing rectifier power converter circuits arrived at from relationships obtained in studying some modes lose their meaning when going to other modes. It is necessary to know a priori in which specific state a given circuit is. A direct estimate of the type of mode can be made most simply when it is possible in some way to determine the parameters of circuit components representing critical states of circuits. An attempt is made here to solve the problem of making this determination for uncontrolled and controlled, thyristor, in particular, rectifier converters containing in their input an m-phase symmetric sinusoidal and nonsinusoidal (polyharmonic) e.m.f. system, the appropriate number of rectifiers connected in radial or bridge circuits, various types of capacitive and inductive filters, and a counterelectromotive force in the internal AND/OR circuits in the d.c. output system. The solution covers a great many specific pieces of equipment; about 130 different classes of circuit structures are taken into account for rectifier converters operating in various modes, such as the intermittent output current mode, the continuous mode with the instantaneous switching of internal branches, e.g., the phases of transformers and rectifiers, or with "overlapping" of these branches, in switching mode No 1, or in modes of the k-th order. Pieces of equipment whose equivalent circuits represent particular cases of the general circuit for a given class are united into a single class. Tables for classifying rectifier converters are presented, indicating the class of circuit, equations of criticality, determining parameters and the algorithm for evaluating the type of mode. Mode portraits are presented for rectifier circuits of specific classes along with the block mode structure of various classes of rectifier circuits. Figures 3; tables 2; references 26: 22 Russian, 3 Western, 1 Lithuanian. [39-8831]



## CRITERIA FOR THERMAL STABILIZATION OF SUPERCONDUCTING DEVICES

Moscow ENERGETIKA I TRANSPORT in Russian No 4, 1980 pp 3-9 manuscript received 2 Mar 79

GLEBOV, I. A., VISHNEV, I. P., PRON'KO, V. G. and FILATOV, I. A., Leningrad and Moscow

[Abstract] A major problem in creating superconducting devices is the elimination of the "current degradation" in coils; this degradation is evidenced in the fact that when the finished coil is charged the maximum current density is considerably lower than the critical current density characteristic of the conductor of which the coil is made. This is caused by the premature appearance of electrical resistance, the release of Joule heat and the origin of a normal zone in the coil. The probability of the origin and spread of normal zones in a superconductor is increased by heat exchange conditions, which depend on the hydrodynamic, thermophysical, structural and electrical insulation parameters of the device. The application to a heat liberating conductor of a poorly conducting electrically insulating coating results in a rise in the temperature of the superconducting material and thus increases the probability of the spread of normal zones and the premature transition of the entire coil into the normal state. Thermal stabilization of a superconducting device must be achieved by eliminating the possibility of an inadmissible rise in the temperature of the superconductor, which depends on the intensity of heat exchange; the problem is that the effective dissipation of heat is prevented by the presence of the electrically insulating coating on the conductor and by the finite values of the coefficient of heat transfer from the heat transfer surface to the coolant. A study is made here of the dependence of the thermal conditions of a superconductor on the magnitude of heat release in the conductor and on the thickness of the insulating coating. In addition, an analysis is made of existing criteria for thermal stabilization of superconducting devices. Experimental curves are presented for the change in the temperature difference when cooling by means of liquid helium at atmospheric pressure of an  $Nb_3Sn$  superconductor stabilized by means of copper and coated with a film of brand PETP-P-E electrical insulation 15, 40, 70 and 120 microns thick. It is demonstrated that with an increase in the thickness of the insulating film the difference in temperature between the superconductor and coolant increases. Similar results were arrived at with hydrogen and nitrogen. It is demonstrated that the passing of the superconductor into the normal state depends chiefly on the amount of heat release, as a function of the thickness and thermophysical properties of the insulating coating. The amount of the critical heat release raising the temperature inside the conductor to the point at which the superconductor passes into the normal state is different for each thickness of the

electrically insulating film. For an  $\text{Nb}_3\text{Sn}$  superconductor this heat release varies three- to sixfold depending on the thickness of the insulating coating and the temperature for passage into the normal state. The critical heat release,  $q_g$ , is to be regarded as an important characteristic of superconducting devices. Exceeding  $q_g$  results in transition of the superconductor into the normal state. Representing a particular case of  $q_g$  is  $q_{kr1}$ , standing for the critical heat release in the conductor with which a crisis in the nucleate boiling of helium takes place. It is demonstrated that a criterion for thermal stabilization which takes into account the critical heat release can serve as the major criterion for developing a procedure for calculating the thermal stabilization of superconducting devices. Figures 2; tables 1; references 16: 9 Russian, 7 Western. [39-8831]

UDC [621.315.2:536.483].001

#### CALCULATION OF CHARACTERISTICS OF COMPOSITE SUPERCONDUCTING MATERIALS WITH HIGH JUNCTION RESISTANCE

Moscow ENERGETIKA I TRANSPORT in Russian No 4, 1980 pp 10-16 manuscript received 22 Sep 79, after revision 3 Dec 79

KREMLEV, M. G., Moscow

[Abstract] A study is made of the distribution of current and temperature in composite superconductors characterized by considerable electrical and thermal resistance between the layers of normal and superconducting metal. The junction electrical resistance, i.e., the resistance of the boundary layers between the superconductor and normal metal, plays a considerable role in cryostatic stabilization. Calculation procedures developed in earlier studies are applicable only to the case of fairly slight resistance, when the influence of this resistance from the practical viewpoint is also quite slight. A plane model is discussed of a composite conductor in the form of two strips of a normal and superconducting metal separated by three infinitely thin layers the middle of which creates only thermal resistance, and the other two only electrical. Equations are written for the steady-state distribution of temperature over the length of each layer. Added to the system of equations derived is an equation defining the relationship between the electric field strength and current density in the resistive region and taking into account the critical current density in the superconducting region. The system of equations is represented in a more convenient dimensionless form by means of which solutions can be found on a computer from the boundary of the zone of the conductor in which resistance first originates. With high junction resistance and low thermal conductivity of the superconducting component it is shown that it is possible to reduce the problem to analyzing two simpler equations. It is demonstrated that processes in a composite superconductor can be described by a system of two ordinary differential equations with a set of variable parameters depending on the structure of the conductor. The familiar methods of calculation are limited to the case of

slight junction resistance because of the origin of transverse instability of the resistive state, which is possible because of the finite temperature coefficient of resistance. It is demonstrated that the procedure suggested here makes it possible to determine the minimum propagating current of the normal zone, to plot a set of volt-ampere characteristics for the conductor and to make an analytical determination of the point of the jump from the superconducting to the normal state in the case when the superconductor has low longitudinal thermal conductivity. In the latter case it is possible to bypass calculating the region of instability. References 8: 2 Russian, 6 Western.  
[39-8831]

UDC 537.312.62:531.715.1

#### DYNAMIC AND FLUCTUATION PARAMETERS OF RADIO-FREQUENCY SQUIDS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1725-1735  
manuscript received 8 Jun 79

DANILOV, V. V. and LIKHAREV, K. K.

[Abstract] Superconducting quantum interference devices (SQUIDS) are widely used for many kinds of measurements at low frequencies. The measured signal, such as current, voltage or magnetic field, is converted by the input circuit into magnetic flux which is supplied to the SQUID's sensing element--a superconducting interference device. When the impedance of this circuit is much greater than the input impedance at the frequency of the measured signal, the counter influence of the SQUID on the signal source, both the dynamic and fluctuation influence, can be disregarded. In certain applications this counter influence can be of fundamental importance. Consequently, here a complete theoretical analysis is made of the signal and noise properties of SQUID's, including of their dynamic and fluctuation effect on the input. A computation is made of the entire combination of signal and noise parameters of radio-frequency, i.e., single-contact, SQUID's operating in both the hysteresis and nonhysteresis modes. The analysis is based on an ordinary resistive model of a Josephson junction. General equations are derived for a radio-frequency SQUID. An equivalent circuit is found for a SQUID for a weak low-frequency signal, describing both the output parameters of the SQUID, i.e., the conversion factor and the output noise, and its input parameters, i.e., the driving-point admittance and the noise influencing the source of the measured signal. The hysteresis and nonhysteresis modes are discussed individually. The interference device employed in the ordinary circuit of a radio-frequency SQUID is a superconducting ring coupled with a Josephson junction and this device is inductively coupled with a signal coil and with a tank circuit. Analytical expressions are found for the parameters of the equivalent circuit. The results obtained make it possible to make an analysis of the dynamic and fluctuation influence of SQUID's on specific types of sources of measured signals. The authors thank O. V. Snigirev for discussing the work. Figures 4; references 18: 6 Russian, 12 Western.  
[44-8831]

## DOWN CONVERSION WITH A JOSEPHSON JUNCTION WITH HIGH VALUES OF THE INTERMEDIATE FREQUENCY

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1736-1744  
manuscript received 14 Jun 79

D'YAKOV, V. P., LIKHAREV, K. K. and TARASOV, M. A.

[Abstract] Down converters, i.e., mixers, with an external heterodyne oscillator are now being developed extensively for microwave receivers based on the Josephson effect. The Grimes-Shapiro model (1968) is usually used for analyzing processes in mixers of this sort. This model was suggested for the case when a heterodyne current and signal current close to one another in frequency flow through the Josephson junction. The results of calculations within the framework of the Grimes-Shapiro model prove to be in good agreement with the experimental data when the intermediate frequency is not too high, i.e., on the order of dozens or hundreds of MHz. Microwave mixers now being developed call for the use of high intermediate frequencies on the order of dozens of GHz. The Grimes-Shapiro model is no longer applicable under these conditions. Here a calculation is made of the magnitude of the converted signal in the case of high values of the intermediate frequency,  $\delta$ , and the results of this calculation are compared with experimental data. The analysis is limited to the case when the frequencies of the heterodyne oscillator and signal are higher than the characteristic frequency of the Josephson junction. In the Grimes-Shapiro model it is assumed that the effect on the Josephson junction on an equivalent amplitude-modulated current of  $(a + \varepsilon \cos \delta t) \cos pt$ , where  $\delta = \omega - p$  and  $|\delta| \ll \omega, p$ , does not result in effects other than the origin on the volt-ampere characteristic of the junction of the usual Josephson current steps at voltages consistent with the frequency of the heterodyne oscillator,  $p$ . It is demonstrated here that if in a mixer employing a Josephson junction conversion takes place to a sufficiently high frequency of  $|\delta| \gtrsim \lambda$ , where  $\lambda$  represents the characteristic velocity of relaxation processes in the junction, then the simple Grimes-Shapiro model becomes inapplicable. The amplitude of the converted signal depends on the sign of  $\delta$ , i.e., on whether the frequency of the signal is higher than the frequency of the heterodyne oscillator or vice-versa. This amplitude as a function of the bias voltage has resonance singularities near singular points situated near the edges of Josephson steps on the junction's volt-ampere characteristic. In mixers employing Josephson junctions various modes are possible depending on the ratio of the signal frequency,  $\omega$ , and the intermediate frequency,  $\delta$ , and on  $\lambda$ . When  $\delta, \omega \ll \lambda$ , the Josephson junction is inertialess for all important frequencies and the mixer's operation can be analyzed as for classical mixers. When  $\delta \ll \lambda \ll \omega$ , Josephson current steps appear on the volt-ampere characteristic of the junction. Nevertheless, the junction is inertialess for the intermediate frequency and the Grimes-Shapiro model is valid in this case. When  $\lambda \ll \delta, \omega$ , the dynamic properties of the junction are important both for the signal and intermediate frequency. In this case it is necessary to use equations which describe the quite specific dynamics of the junction, as was done in this paper. Figures 3; references 7: 4 Russian, 3 Western.

[44-8831]



## MIXING OF MICROWAVE SIGNALS ON A SUPERCONDUCTING NIOBIUM NITRIDE FILM

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 2013-2014  
manuscript received 21 May 79

YERU, I. I., KRUT'KO, A. P., PESKOVATSKIY, S. A. and POLADICH, A. V.

[Abstract] The first results are presented of investigations by the authors with respect to mixing of microwave signals with the aid of films of high-temperature superconductors. The investigations were conducted in the 3-cm and 8-mm wavelength band on films of niobium nitride deposited on substrates of optically polished monocrystalline sapphire. The film microbridge, which performed the role of a nonlinear element had a width of 2 micrometers and a thickness of 50 nanometers, and its critical temperature was approximately 13 K. The results obtained point to the fact that a practical construction of cyroelectronic microwave mixers operating at 10-15 K temperatures and possessing high operating characteristics can be developed on the basis of superconducting niobium nitride films. References: 3 Russian.  
[68-6415]

UDC 621.375.7

## PROPERTIES OF TWO-FREQUENCY DEGENERATE PARAMETRIC AMPLIFIERS WITH EXTERNAL PUMPING BASED ON A JOSEPHSON JUNCTION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2204-2215  
manuscript received 19 Jul 79

KUZ'MIN, L. S., LIKHAREV, K. K. and MIGULIN, V. V.

[Abstract] A consistent theory is developed for the signal and noise properties of a two-frequency degenerate parametric amplifier with external pumping in which the nonlinear reactor is a Josephson junction. The operating conditions of such amplifiers are studied both with the use of the fundamental of the pumping frequency and with doubling of the pumping frequency. The principal equations and method of analysis are the same as used in the previous article [see "Radiotekhnika i elektronika," Vol 25, No 10, Oct 80, pp 2195-2203]. The most realistic case is analyzed where no-load operation is realized with respect to no-load combination frequencies as well as with respect to harmonics of the pumping frequency. It is shown that the amplifier can have a very low noise temperature, even lower than the physical temperature in either working mode. The authors thank A. N. Vystavkin, V. N. Gubankov and V. N. Radzikhovskiy for useful discussions. Figures 7; references 12: 6 Russian, 6 Western.  
[80-6610]



**PROPERTIES OF A SINGLE-FREQUENCY NONDEGENERATE PARAMETRIC AMPLIFIER WITH EXTERNAL PUMPING BASED ON A JOSEPHSON JUNCTION**

Moscow **RADIOTEKHNIKA I ELEKTRONIKA** in Russian Vol 25, No 10, Oct 80 pp 2195-2203  
manuscript received 19 Jul 79

**KUZ'MIN, L. S., LIKHAREV, K. K. and MIGULIN, V. V.**

[Abstract] A theory is proposed for a single-frequency nondegenerate amplifier with external pumping that uses a Josephson junction as the parametric element. The signal and noise properties of the amplifier are calculated within the framework of the conventional resistive model. It is shown that amplification takes place in a certain pumping frequency band below the signal frequency. The dc component of the inductance of the Josephson junction has a strong effect on amplification properties. It is shown that using external pumping in a single-frequency nondegenerate amplifier improves noise characteristics somewhat as compared with self-pumping. The authors thank A. N. Vystavkin, V. N. Gubankov and V. P. Zavaleyev for discussing the work. Figures 7; references 10: 6 Russian, 4 Western.  
[80-6610]

ELECTRICAL ENGINEERING EQUIPMENT AND  
MACHINERY: APPLICATIONS AND THEORY

UDC 621.311.6.049.77

VOLTAGE TRANSFORMER BASED ON A PIEZOELECTRIC TRANSFORMER

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 8, 1980 pp 41-43

MISHACHEV, A. P., UDOD, V. A. and FILATOV, N. A., Ryazan' Radio Engineering Institute

[Abstract] Piezoelectric transformers, both voltage and current, are presently being developed for use in miniature secondary power supplies. A piezoelectric transformer has no windings and emits a low level of noise, and there is practically no limit for reducing the power for a transformer of this type. They are also lightweight and in principle can be executed as flat pieces. A functional diagram and characteristics are presented for a stabilized voltage transformer of an integrated design based on a piezoelectric current transformer. The components of the voltage transformer are a master oscillator, a control element, a d.c., or differential, amplifier, a comparator, a switching circuit, the piezoelectric current transformer and a rectifier. The operating frequency of the master oscillator is controlled by the voltage. This is accomplished by means of a feedback signal from the output of the comparator. This transformer has a load output of 1.75 W with a current load of 0.175 A and the efficiency of the resulting secondary power supply is greater than 75 percent. The circuit can be executed in integrated form and the piezoelectric element itself can serve as the substrate. A determination is made of the shape of the signal for the optimal excitation of piezoelectric current transformers. The length of the piezoelectric plate must be a multiple of the length of the exciting wave and equal an odd number of exciting wavelengths. The first harmonic of the excitation voltage, for which is used a signal of the "meander" type, or a signal of another shape or similar in spectrum, must match the first mode of the piezoelectric transformer. Figures 4; references: 1 Russian.  
[24-8831]

## CALCULATION OF THE EXTERNAL MAGNETIC FIELD OF GEOMETRICALLY SIMILAR ELECTRICAL MACHINES

Moscow ELEKTROTEKHNIKA in Russian No 8, 1980 pp 8-11 manuscript received 26 Jul 79

ROYTGARTS, M. B., engineer

[Abstract] Approximation equations are derived for rough and verifying calculations of the external magnetic fields of a series of geometrically similar a.c. and d.c. machines with a cylindrical outside surface. The calculation method suggested reduces to finding the optimal design for the basic machine and then on the basis of similitude methods recalculating all machines of the series. The magnitude of the external magnetic field depends substantially on the geometry of the machine and in particular on the ratio of its length and outside diameter. This dependence is taken into account by replacing the machine with an equivalent solid of revolution, i.e., a spheroid, and solving for it the external boundary problem for the Laplace equation. The first harmonic of the forward-revolving wave of the field is assigned on the surface of the spheroid and an expression is written in prolate spheroidal coordinates for the complex amplitude of the strength of the electrical machine's external magnetic field. The proportion of higher harmonics in the field's space spectrum is lowered farther from the surface of the machine and at distances exceeding the machine's dimensions it is sufficient to consider only the first term of the series written. This expression is used to compare the lower space harmonics of the same order of two machines from the series of machines. By solving the boundary problem, equations are derived for the relationship of the remaining components of the external magnetic field strength of two machines of the series. For purposes of simplification, spheroidal coordinates are expressed in terms of spherical and approximate estimates are used for associated Legendre functions and their derivatives. An analysis is made of the dependence of the strength of the external magnetic field on the nominal power in a series of machines. It is shown that as the power increases within a series of machines the amplitude of the space harmonics of the external magnetic field also increases and that this increase is of the order of magnitude of the number of poles and is more rapid, the greater the number of poles. Magnetic dipole moments are approximately proportional to the nominal power. The results are given of calculations of the external magnetic field strength of series of double-pole and four-pole synchronous machines with a capacity of up to 3200 kW. Calculations were performed by computer for each machine of the series and by the approximation method described. The accuracy achieved by the approximation method is sufficient for engineering calculations and results in a considerable saving of machine time. Figures 2; references: 6 Russian.

[36-8811]

## MAGNETIC FIELD OF A MOTOR WITH SHIELDED POLES

Moscow ELEKTROTEKHNIKA in Russian No 8, 1980 pp 22-24 manuscript received 1 Jun 78

IVANOV, V. V., engineer

[Abstract] Analytical expressions are derived which make it possible to calculate values of the magnetic field induction in the air gap of a motor with shielded poles as a function of the current of the full-pitch winding. By superposing two independent tubes of flux, one of which is closed through the yoke and the other through the pole piece, a visual picture is presented of the calculated tube of magnetic flux. The resulting field is constructed by the superposition of fields, one of which is produced by the repulsion of the pole piece zone, and the other by the repulsion of the stator's yoke. In constructing this diagram the results were taken into account of an experimental measurement of magnetic flux closing through the yoke and through zones of the air gap. For the calculation tube, an equivalent circuit is presented for the magnetic circuit, incorporating the magnetomotive force of the winding's current, the reluctance of sections of the calculation tube in the steel of a pole and the rotor and in two zones of the air gap, and the reluctance of the stator's yoke. Expressions for induction are obtained which take into account field coefficients which depend on the order of magnitude of the harmonic, the angular position of the axis of the winding and the degree of saturation of the magnetic circuit. The results of the theoretical analysis are confirmed by experimental dependences of the magnetic field induction on the current of the full-pitch winding as a function of the air gap coordinate. For this purpose, tests were made of a DAV-4 motor with a rotor diameter of 28.5 mm and the full-pitch winding charged with 50-Hz alternating current. The effective value of the winding's magnetomotive force equaled 20 A. For measuring the field, around the circumference of the rotor, without a winding, concentric coils were placed at an interval of six degrees, whose e.m.f. was measured by means of a vacuum-tube voltmeter. The magnetic circuit was magnetized by the direct current of the excitation coils for the purpose of determining the nature and magnitude of the field in the air gap for three states of the magnetic system. Steel E12 was used for the magnetic circuit. The experimental and theoretical characteristics agree with sufficient accuracy. The results of studying the magnetic field in the air gap and magnetic circuit of a motor with shielded poles demonstrate that the magnetomotive force in the steel of the magnetic circuit with the existence of a considerable difference in the length of lines of force closing through the yoke or pole piece accounts for the discrepancy observed between the actual and previously assumed magnitude and distribution law of the magnetic field induction in the air gap. The analysis conducted relates to all electrical machines with salient poles. By using the analytical expression obtained here it is possible to calculate with sufficient accuracy the field of the air gap or of the winding of a motor with a salient pole design when the magnetic circuit is saturated uniformly. Figures 4; references: 3 Russian.

[36-8831]

## SELF-TUNING SWITCHING UNIT FOR THYRISTOR CONVERTERS WITH SEPARATE CONTROL

Moscow ELEKTROTEKHNIKA in Russian No 8, 1980 pp 48-49 manuscript received 12 Jul 79

GORODETSKIY, V. A. and ROMANOV, V. A., engineers

[Abstract] A description is given of self-tuning switching units (UPS's) for general-purpose applications in power converter equipment, which make it possible to shorten substantially the length of the interval without conduction. The unit described makes it possible to scan and self-tune without using a special a.c. control source. In its scanning mode it selects sets of rectifiers until a load current appears. It sustains the working set in the switched-on stage until the disappearance of load current. It blocks control pulses from a nonworking set and control pulses of the converter during an interval without conduction. And it connects without delay a previously operating set when current arises in it during a pause without conduction. The UPS described is assembled from integrated microcircuits in the form of R-S flip-flops. The circuitry forms a multiphase self-excited multivibrator which enables the UPS to operate in the scanning mode. The operation of the circuit is described in detail. A circuit diagram is presented for a UPS implemented on the basis of the functional diagram discussed. Series K106 integrated microcircuits are used; it is possible to use series of two types, such as K133 and K155. A microcircuit with an open collector output is used to form converters which function as power amplifiers. RC circuits are used as delay circuits. Resistors determine the duration of the interval without conduction and the rectifier scanning period. The UPS described makes it possible to regulate the duration of the interval without conduction from 3 to 30 ms and the rectifier set scanning period from 3 to 10 ms. The length of the leading edge of output pulses is 5  $\mu$ s and the power requirement from a  $\pm 12$  V supply is 50 mA. Figures 3; references: 4 Russian. [36-8831]

## A CURRENT BREAKER WITH ELECTROEXPLOSIVE DRIVE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 91-93 manuscript received 14 Nov 78

BELAN, V. G. and DURMANOV, S. T.

[Abstract] A fast-acting breaker is described in which the conducting path is destroyed by a shaped pressure wave in a dielectric. The breaker is enclosed in a glass-textolite case in which a wedge-shaped recess is filled with oil. Compressed between metal blades in the lower section of the housing is copper or aluminum foil that acts as the destructible conductor. An explosive drive made of copper or



aluminum conductors is situated on a cylindrical surface in the upper cover of the breaker. Energy of 2-3 kJ is fed to the drive from a capacitor bank through a transformer. The pulses have an amplitude of 30-45 kV and current rise time of about 1  $\mu$ s. With explosion of the drive conductors, a converging cylindrical shock wave is produced in the quenching dielectric (vaseline, transformer oil). When the wave reaches the destructible conductor, the energy is concentrated in a region about 1 cm wide. The flow of dielectric covers the gap and quenches the resultant arc. Reflection of the oil flow from the bottom plate is prevented by recesses filled with quartz sand. In operation with an inductive load, the device can handle a current of about 50 kA in about 10  $\mu$ s. The authors thank I. A. Ivanov for interest in the work, and V. S. Dykov, V. F. Levashov and K. V. Solonov for assisting with the experiments. Figures 3; references 4: 3 Russian, 2 Western. [61-6610]

UDC [621.311.25:621.039]:621.313.333

#### POWERFUL ASYNCHRONOUS ELECTRIC MOTORS FOR PRINCIPAL CIRCULATING PUMPS OF ATOMIC POWER PLANTS

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 80 pp 5-9

VERBER, O. L., engineer, GERASIMENKO, Yu. N., candidate of technical sciences, ZHOROV, S. I., MARCULIS, V. Ya., engineers, NEYMAN, Z. B., candidate of technical sciences, and PEKERMANN, G. A., engineer, "Uralskoe Elektromashstroenie" (Ural Heavy Electrical Machine Construction Plant)

[Abstract] The Ural Heavy Electrical Machine Construction Plant (Imeni V. I. Lenin) has developed and manufactured special vertical asynchronous motors with a short-circuited rotor at a rotation frequency of 1000  $\text{min}^{-1}$ . The motors are used with the principal circulating pumps of atomic power plants. The basic technical data of the motor are presented. The design and characteristics of these motors differ substantially from asynchronous pumps of other designations because a number of special requirements are imposed on them. Development of earthquake-proof type motors for atomic power plants located in seismic areas demanded the solution of a number of complex technical problems. Start-up characteristics, self-starting, bearings and lubricant system, vibration level and control sensors are discussed. Figures 4. [73-6415]

STUDY OF ELECTRIC STRENGTH OF INSULATION OF 500 kV DISCONNECTING SWITCH FOR SAYANO-SHUSHENSKAYA HYDROELECTRIC POWER STATION

Moscow ELEKTRICHESKIY STANTSII in Russian No 9, Sep 80 pp 42-46

RUDAKOV, V. M., candidate of technical sciences, and TABARDANOVA, M. P., engineer.  
NIPT [Scientific-Research Institute of Direct Current]

[Abstract] The first model of the 500 kV disconnecting switch for the Sayano-Shushenskaya Hydroelectric Power Station was produced by the Velikolukskiy High-Voltage Equipment Plant on the basis of a RNDZ-330U disconnecting switch. The results are presented in tables of tests of the intercontact gap and the base insulation of the 500 kV disconnection switch. The tests included switching and thunder-storm pulses and a smooth voltage of commercial frequency. Recommendations are made with respect to the method of testing higher-voltage disconnecting switches. Figures 5; tables 3; references: 2 Russian.  
[73-6415]

## EXCITATION OF HYPERSONIC WAVES BY MEANS OF TWO-CONDUCTOR LINES IN THE SHORTWAVE PART OF THE MICROWAVE BAND

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1597-1601  
manuscript received 13 Dec 78

GRIGOR'YEV, M. A., USHAKOV, V. Yu., TOLSTIKOV, A. V., PYLAYEVA, G. I. and ZAYTSEV, B. D.

[Abstract] A demonstration is given of the fact that it is possible to create effective broadband electroacoustic transducers for the shortwave section of the microwave band on the basis of two-conductor lines without any kind of reactive matching elements. At the present time elastic waves in the microwave band are mainly excited by means of piezoelectric films to which electromagnetic energy is supplied by excitation devices. It is difficult to create an effectively functioning excitation system for the shortwave section of the microwave band because of a reduction in the optimal thickness of piezoelectric films and a corresponding lowering of their impedance. A study is made of the feasibility of creating electroacoustic transducers for the 3-cm radio wave band which use as systems supplying microwave energy two-conductor lines without reactive matching elements. A numerical calculation was made of the impedance,  $Z(\omega)$ , of a piezoelectric transducer consisting of a superfilm of SiO<sub>2</sub>, a piezoelectric film of ZnO and a subfilm of Au. This transducer is placed between a Chebyshev wave impedance transformer and an Al<sub>2</sub>O<sub>3</sub> acoustic line. The acoustic line and ZnO piezoelectric crystal are oriented with their optical axes along the longitudinal coordinate. The superfilm and subfilm are assumed to be isotropic. The electric microwave field is created in the piezoelectric crystal because of an alternating difference in potential between the subfilm and one of the conductors of the supplying line. Equations are derived which make it possible to determine the thickness of the piezoelectric film, superfilm and subfilm and to compute the conversion factor for the case when the piezoelectric transducer is the load of a transmission line with specified wave impedance. A schematic diagram is shown of the transducer based on a coaxial line studied theoretically; a two-stage Chebyshev transformer with a wave impedance differential of about 30 serves as the matching stub. The transducer described was tested by the pulse-echo method employing a microwave receiver with sensitivity of approximately 115 dBW with a transmission band not narrower than 9 MHz. A standard signal generator with output power of 0.1 to 1 mW was used as the pulsed microwave power source. An experimental frequency-versus-conversion-factor curve is given, which shows that the width of the frequency band for a conversion effectiveness of 14 to 17 dB equaled about 32 percent in terms of the relative frequency difference expressed as  $(f - f_0)/f_0$ , where  $f_0$  is the mid-band frequency. Figures 3; references: 4 Russian.  
[44-8831]

## LIGHT MODULATION BY ACOUSTIC WAVES IN AN ANISOTROPIC MEDIUM

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1957-1965  
manuscript received 16 May 79

BALAKSHIY, V. I. and PARYGIN, V. N.

[Abstract] A theoretical analysis is made of the operation of an acoustooptical modulator with an isotropic diffraction of light. Principal consideration is given to the choice of the optimum parameters of acoustooptical units, which ensures derivation of a maximum modulation band. Calculations are presented which show that anisotropic diffraction of light can be used successfully in acoustooptical modulators. The best characteristics of the modulators are obtained when the light falls on the acoustooptical unit at a Bragg angle close to zero. Such a geometry of an acoustooptical interaction is assured by the choice of the corresponding polarization of the incident light and the cut of the modulator crystal. A comparison of the acoustooptical modulator with isotropic and anisotropic diffraction shows that with identical parameters of the unit, the modulator with anisotropic diffraction has a larger modulation band, and this difference is sharper the larger the value of the D. Maydan parameter  $\alpha$  (See IEEE J.1970, QE-6, 1,15]. However, the interaction of light and acoustic beams deteriorates with an increase of  $\alpha$ . Consequently, optimization of an acoustooptical modulator to the maximum efficiency of modulation gives a similar value of the optimum parameters of the modulators with isotropic and anisotropic diffraction. By virtue of the fact that the anisotropic diffraction applies less rigid requirements on the width of the acoustic beam, it may prove to be preferable for a high-frequency acoustooptical modulator operating in the 1-2 GHz band. Figures 6; references 6: 4 Russian, 2 Western.  
[68-6415]

## MUTUAL TRANSFORMATION OF BULK AND SURFACE ACOUSTIC WAVES ON A PERIODICALLY PERTURBED SECTION OF THE SURFACE OF AN ELASTIC SOLID (REVIEW)

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1569-1587  
manuscript received 18 Dec 79

GULYAYEV, Yu. V. and PLESSKIY, V. P.

[Abstract] A description is given of an effective method of exciting and receiving surface acoustic waves, which is based on the mutual transformation of surface and bulk acoustic waves on a periodically perturbed section of the surface of an elastic solid. An illustration is given of an Ash converter in which a bulk wave strikes

a periodically uneven section and is partly transformed into a Rayleigh surface wave. In the case of normal incidence the period of the structure must be equal to or close to the length of the surface acoustic wave generated. For this purpose Akhromeyeva and Krylov (1977) used magnesium models on whose surface had been created, by machining, grooves with a triangular cross section. The name "surface structure converter" was given to this device. A list is presented of the advantages which a surface structure converter has over the opposing-pin converters widely used at the present time for exciting surface acoustic waves. Among these are the fact that a surface structure converter can function with nonpiezoelectric substrates, is but slightly sensitive to local defects of the structure and fabrication errors and does not have to contain conducting metallic elements. In addition is the fact that by varying the depth of the grooves it is possible to control the degree of coupling between bulk and surface waves and at the same time to create structures with any number of grooves while avoiding secondary effects. Also, current methods of fabricating gratings make it possible to create structures with a period of less than 0.1 micron and therefore to create surface acoustic wave converters for frequencies up to 10 GHz. The method of "coupled modes" is discussed, which can be used for describing Bragg reflection of waves from periodic structures. As an example the problem is solved of the Bragg reflection of a Rayleigh surface acoustic wave obliquely incident to a periodically uneven section of the surface of an isotropic elastic solid. The calculation presented takes into account the mutual reflection of surface acoustic waves and is suitable for gratings of any length. The method of "coupled modes" is generalized for the case when the length of the surface acoustic wave is close to the period of the structure and it is necessary to take into account the interaction of the incident wave, the reflected wave and the wave going off into the body of the solid. Structures based on this kind of interaction are used for transforming a surface acoustic wave into a bulk wave and vice-versa. The method of three coupled waves is used for describing the functioning of a surface structure converter in the reception and excitation of shear surface acoustic waves and Rayleigh surface acoustic waves. It is demonstrated that by means of a surface structure converter it is possible to excite effectively Love waves and shear surface electroacoustic waves. Shear surface waves penetrate deeply into the substrate and are therefore influenced by defects in the surface layer of the material to a lesser extent than are Rayleigh waves, a fact which is important at frequencies greater than 1 GHz. In opposing-pin converters metalization of the surface of the piezoelectric influences the structure of the shear wave in such a manner that when the wave exits from beneath the converter's electrodes a quite considerable loss of energy takes place on account of scattering into the body. It is possible to overcome this difficulty by using surface structure converters containing a great number of very fine grooves. The frequency dependences are found for the coefficients of the generation, transmission and reflection of surface acoustic waves, along with the dimensions of a grating which most effectively generates and receives Love surface waves. The problem of the conversion of a bulk wave normally incident to the perturbed section into a Love wave is discussed. The expressions obtained for a Love wave are totally applicable in the case of a shear surface electroacoustic wave. An equation is derived for the optimal length of the grating, whereby practically all the energy of the incident bulk wave is converted into the energy of surface waves. The question of the influence of the anisotropy of crystals on the functioning of a surface structure converter is discussed. The characteristic length of the structure with which substantial attenuation of the



takes place depends considerably on the anisotropy of the crystal. It is shown that scattered longitudinal and transverse waves carry away approximately equal energy flux. The phenomena describes relate essentially to the field of wave diffraction and the diffraction of acoustic waves in elastic solids has been studied but little hitherto. The authors thank V. I. Grigor'yevskiy for assistance in writing the paper, and T. N. Kurach and Ye. V. Shuba for assistance during formulation of the work. Figures 9; references 26: 15 Russian, 11 Western.  
[44-8831]

UDC 621.372.54

#### REALIZATION OF WIDE-BAND FILTERS FOR SURFACE ACOUSTIC WAVES

Moscow ELEKTROSVYAZ' in Russian No 9, 1980 pp 43-46 manuscript received 21 May 79

ZNAMENSKIY, A. Ye. and KRYLOV, L. N.

[Abstract] The possibility is considered of a significant decrease of the losses in the passband of wide-band surface acoustic wave (SAW) filters. The following subjects are discussed; 1) Special features of construction of a SAW filter; 2) Methods of decreasing losses; 3) Multichannel transducer with frequency separation (MTFS) of channels; 4) Connection diagram of MTFS channels; 5) Construction of a transducer in the form of an opposing-pin structure (OPC); and 6) The results of experimental checking. It is shown that use of a multichannel OPC is an efficient method of reducing losses in the passband of wide-band filters. Another most significant advantage of a multichannel OPC is the possibility of obtaining low unevenness of the amplitude-frequency characteristic in the wide passband. It is possible with miniaturization of the inputs of the individual channels of the OPC, and with the aid of electronic switches, to accomplish both rearrangement of the average frequency of the passband of the filter as well as rearrangement of the filter with respect to the width of the band. Figures 5; references 8: 6 Russian, 2 Western.  
[72-6415]

## CHANGE OF CHARACTERISTICS OF ACOUSTIC SIGNAL DURING VERTICAL SOUNDING OF THE BOUNDARY LAYER OF THE ATMOSPHERE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1801-1809  
manuscript received 12 Jul 79

ANDRIANOV, V. A., ARMAND, N. A., VETROV, V. I. and KAL'TSYUN, V. A.

[Abstract] The results are presented of measurements of the principal characteristics of a diffused signal (amplitudes, carrier frequencies, form of spectra) during vertical acoustic sounding of the atmosphere. Changes of the doppler frequency of the signal as a function of the height of the dispersion space are used for evaluation of the variations of the speed of vertical atmospheric flows. The following subjects are discussed: 1) Recording conditions and method of processing measurements; 2) Change of the amplitude of the diffused signal under various metrological conditions; and 3) Measurement of the vertical wind and variations of the spectrum of an acoustic impulse. It is concluded that the investigations conducted show the dependence of the change of the maximum height of the acoustic sounding on the meteorological conditions of the atmosphere. The maximum value of the height of sounding (850 m) was observed in a period of frontal activity. Measuring the doppler shift of the carrier frequency of the signal made it possible to determine the height profile of the variations of the velocity of the vertical atmospheric measurements up to a height of 400-500 m with a spatial resolution of 17 m and a precision of 0.1-0.2 m/sec. This improves the possibility of measurement with the aid of standard meteorological instruments. Analysis of the spectrum of the diffused signal shows the effect of horizontal wind and the width of the antenna radiation pattern on the change of the form of the spectrum, caused by the transfer of the nonuniformity of the atmosphere across the propagation course of the acoustic waves. Figures 5; references 10: 5 Russian, 5 Western.  
[68-6415]

## SCATTERING OF A PLANE WAVE ON A COMPOSITE CYLINDER

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1602-1606  
manuscript received 4 Apr 79

CHECHETKA, V. V. and FEDORENKO, A. I.

[Abstract] An illustration is given of the cross section of an infinite round ideally conducting cylinder of radius  $a$  with  $M$  sector cutouts characterized by an angular width of  $\alpha_k$ , by angle  $\beta_k$  representing the position of the beginning of the sector, and by the radius of the base,  $b_k$ , where  $1 \leq k \leq M$ . There are two types of cutouts; for a cutout of the first type  $b_k = 0$ , and the base of a cutout of the second type,  $b_k \neq 0$ , is characterized by a certain input impedance of  $Z_k$ , where  $Z_k = 0$  for an ideally conducting surface. The region of a sector cutout where  $b_k \leq r \leq a$  is filled with a dielectric with electrodynamic parameters represented by step functions in the radial direction. The number of layers can be arbitrary. A plane wave strikes the cylinder perpendicular to its axis. It is necessary at the observation point to determine the scattered field satisfying the Maxwell equations, the boundary conditions for continuity on surface  $r = a$  and the condition for radiation with  $r \rightarrow \infty$ . The cases of electric and magnetic waves are considered individually. The problem is solved by expanding the unknown fields into Fourier series in terms of systems of trigonometric functions orthogonal at various intervals and by determining the unknown expansion coefficients by solving an infinite system of linear algebraic equations. The solution is found by calculating values of the unknown scattered fields with  $r \geq a$ . For specific parameters of the cylinder calculated scattering diagrams are given for the incidence of plane E- and H-polarization waves symmetric relative to the cutout. For the sake of comparison scattering diagrams are also shown of a cylinder with a cutout with same dimensions but without a dielectric, of a homogeneous ideal conducting cylinder, and of a homogeneous cylinder completely covered by a film of dielectric. It is shown that the presence of a cutout results in considerable changes in the scattering properties of a solid in the irradiated region. Filling the cutout with an absorbing dielectric results in a reduction in the intensity of scattered fields in this region. By the example of a round cylinder with a single sector cutout it is demonstrated that the scattered fields depend substantially on the shape of the cross section of the cylinder and on the parameters of the material filling the cutout. Figures 2; references 5: 2 Russian, 3 Western.

[44-8831]

## DIFFRACTION OF A PLANE ELECTROMAGNETIC WAVE BY AN IDEALLY CONDUCTIVE SPHEROID

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2056-2065  
manuscript received 27 Feb 79

FARAFONOV, V. G. and SLAVYANOV, S. Yu.

[Abstract] A new method is proposed for solving the problem of diffraction of an arbitrarily incident plane electromagnetic wave by an ideally conductive spheroid. The solution is different from conventional methods in the new choice of a basis for expansion with respect to spheroidal functions, and in division of the total field into a part that is independent of the angle of rotation, and a part that has a zero average with respect to angle of rotation. The diffraction problem is solved separately for each part. The part that is independent of the angle of rotation is solved explicitly by introducing Abragam potentials. The other part of the field is represented as expansions with respect to certain types of vector spheroidal functions. Infinite systems of linear algebraic equations are found for the coefficients of these expansions when boundary conditions are met. It is proved that these systems can be made quasi-regular and solved by reduction to a finite number of equations. The proposed choice of basis makes the linear algebraic systems simpler than in conventional methods because their coefficients depend on a minimum number of integrals of angular spheroidal functions. In the case of a disk, the explicit part of the field can be found by the proposed method, but the choice of the basis for the expansion of the scattered field does not meet the boundary condition for diffraction on the edge of the disk. References 11: 9 Russian, 2 Western.  
[80-6610]

## INVESTIGATION BY THE METHOD OF PHYSICAL MODELING OF ELECTROMAGNETIC FIELDS NEAR METALLIC BODIES IN A CONDUCTING MEDIUM

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1756-1758  
manuscript received 6 Mar 79

GASHEVSKAYA, O. S., GUGIN, A. S., DYAKIN, V. A., KARNISHIN, V. V., MAKSIMENKO, V. G. and RYAZANTSEV, A. M.

[Abstract] The results are given of a study by the physical modeling method of the diffraction of plane electromagnetic waves in metallic bodies with a simple shape in a conducting medium. These studies were conducted to solve problems relating to geophysical prospecting in the VLF band. A basin measuring  $4 \times 3 \times 2.8 \text{ m}^3$  was used, filled with a water solution of NaCl. A single-turn loop antenna surrounding the basin in its vertical cross section was used to excite an electromagnetic field in

the solution. The upper part of the loop consisted of several parallel wires stretched across the basin to create a plane linearly polarized field. A symmetric electric dipole 3.5 cm long, whose length equaled about  $1/4$  the thickness of the skin layer in the electrolyte at the operating frequency, was used as the receiving antenna. The signal from the antenna was sent through a shielded cable 1 m long to the input of an amplifier-converter with an independent power supply, in which the signal was amplified and converted into a signal with a frequency of 465 kHz. This signal was sent through a cable extended along the bottom of the basin to the input of a receiver. The amplifier-converter was placed in an airtight container. Control measurements were performed with metal spheres and were compared with calculations of a diffraction field by the method of summing spherical functions, i.e., multipoles, from a complex argument, described in previous studies (1975 and 1977). Good agreement between the experimental results and the strictly numerical proved it was feasible to use the measuring system described for studying diffraction fields near solids of revolution with transverse dimensions approximately greater than  $0.2\delta$ , where  $\delta$  is the thickness of the skin layer in the solution, and for evaluating the accuracy of approximation methods of analyzing fields. Estimates were made of the limits of applicability of the approximation method of physical optics for calculating the short-range diffraction fields of bodies whose dimensions are less than the wavelength in the medium. For this purpose theoretical calculations were made of fields near an ideally conducting prolate spheroid. For purposes of modeling a round metal cylinder was used with hemispheres attached to its ends, close in shape to a spheroid. A comparison of the theoretical results and the results of modeling demonstrates that the method of physical optics results in a minor error. The experimental results demonstrate certain rules regarding the formation of electric diffraction fields in the vicinity of metallic bodies placed in a conducting medium. On the exposed side of the body at a distance of about  $0.1\delta$  the tangential component of the field is approximately 9 to 16 dB lower than the primary field. On the shaded side the field is 16 to 22 dB less intense than under unperturbed conditions. A 2- to 5-dB intensification of the field is observed near the ends of the body. At a distance from the body of one to two skin layers the total electric field near solids of revolution with transverse dimensions smaller than the thickness of the skin layer is practically equal to the incident field. The authors thank V. V. Akindinov, A. D. Petrovskiy, L. V. Smirnov and Yu. N. Troshkin for assistance in conducting the experiment. Figures 5; references 7: 5 Russian, 2 Western.

[44-8831]



# DIFFRACTION OF SURFACE ELECTROMAGNETIC WAVE AT THE END OF A PLANE SEMI-INFINITE DIELECTRIC WAVEGUIDE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 23, No 9, Sep 80 pp 1862-1872  
manuscript received 19 Jun 79

VASIL'YEV, Ye. N., POLYNIKIN, A. V. and SOLODUKHOV, V. V.

[Abstract] A general approach is developed for the solution of a problem concerned with diffraction of a surface wave at the geometrically irregular part of a dielectric waveguide, applicable to the simplest and most typical form of nonuniformity--the open end of a waveguide. The numerical method of solution employed is based on the use of a means for integral equations composed with respect to equivalent surface currents. The concept of currents in the form of a sum of "uniform" (propagating modes in waveguide) and "nonuniform" components is essential. The approach proposed is a generalized method developed and applicable to the solution of the problem of diffraction of a plane wave at a dielectric wedge, and to the case of an important characteristic of surface waves. The results in table form are presented of calculations for the E- and H-modes. An appendix to the paper is concerned with calculation of additional terms in the right members of integral equations. Figures 5; tables 4; references 8: 5 Russian, 3 Western (1 in translation).  
[68-6415]

# APPLICATION OF THE AUTONOMOUS MULTIMODE BLOCK METHOD TO ANALYZING COUPLED STRIPLINES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1759-1761  
manuscript received 16 Apr 79

NIKOL'SKIY, V. V. and GOLOVANOV, O. A.

[Abstract] The autonomous multimode block method has been used to algorithmize a number of electrodynamic problems. Autonomous multimode blocks represent homogeneous parallelepipeds and the method differs from the familiar method of partial regions essentially only in the use of the decomposition principle, whereby each partial region is analyzed as an independent or autonomous electrodynamic object. Each region receives its own descriptor in the form of a conduction matrix. The conduction matrix can be transformed into a scattering matrix. By joining individual blocks whose descriptors are first found, i.e., by means of recombination, a mathematical model is constructed of the original object. Here the autonomous multimode block method is applied to constructing a mathematical model of coupled striplines. An illustration is given of the cross section of the line modeled and the decomposition diagram serving as the basis for the algorithm is presented. Curves are shown, illustrating the dependence of the relative propagation constant of the fundamental

wave on the distance between coupled lines for three values of the width of strip conductors. Results are given, illustrating the influence of the thickness of the substrate on the relative propagation constant of the fundamental wave. Curves are also shown, illustrating the influence of the shield. It is shown that when the dimensions of the shield are not great and, consequently, the dimensions of the autonomous multimode blocks are not too great, the accuracy of the modeling method is higher than when these dimensions are great. Figures 4; references: 2 Russian, [44-8831]

UDC 621.385.6

#### HIGH-EFFICIENCY DIRECTIONAL SYNCHROTRON RADIATION OF AN INTENSE STREAM FROM RELATIVISTIC ELECTRON OSCILLATORS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1945-1956  
manuscript received 24 Jul 79

AFONIN, A. M., KARAVETS, V. I. and CHEREPENIN, V. A.

[Abstract] The directional synchrotron radiation of a stream of relativistic electron oscillators formed by a homogeneous magnetic field is considered. A procedure is developed for analysis of multimode processes which makes it possible to study the properties of synchrotron radiation of a relativistic electron stream in a wide, open waveguide and to obtain data concerning its directivity and mode composition. The narrow directional diagram encountered is chiefly explained by the process of collective spontaneous radiation of the sequence of electron bunches. The possibility is shown of obtaining the considerable efficiency of  $\sim 30\%$  with the use of the synchrotron radiation of the intense relativistic stream in a homogeneous magnetic field and the self-consistent interaction in the limits of the cone of this radiation. A self-filtering mode and the removing of parasitic self-excitation at critical frequencies are assured by diffraction losses in the open waveguide. Figures 5; references 16: 15 Russian, 1 Western.  
[68-6415]

ELECTRON AND ION DEVICES; EMISSION;  
GAS-DISCHARGE AND ELECTRON-BEAM DEVICES

UDC 537.533.3

AN ELECTRON GUN THAT PRODUCES A HIGH-INTENSITY PYRAMIDAL FLUX OF ELECTRONS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2180-2188  
manuscript received 27 Oct 78

MUKHIN, S. V. and TRENEVA, S. N.

[Abstract] A unipotential electron gun is developed with simplified electrodes that produces a nearly rectangular pyramidal flux of electrons. The initial model is a spherical diode with outer cathode and inner anode. A converging pyramidal beam is cut out of a one-dimensional electron flux in a spherical coordinate system. The edges of the pyramid are radii of the initial spherical diode, and the action of the discarded part of the flux is replaced by the equivalent effect of the field of the focusing electrode. The electrode configuration is experimentally determined from considerations of simplicity of manufacture and technological feasibility of assembly. To simplify the configuration, the exact shape of the focusing electrode is approximated by a combination of electrodes of simplified shape that produce equivalent tapered beams, approximately meeting boundary conditions on the edge of the flux. The principal relations are given for the proposed gun, and an analysis is made of the influence of the anode aperture and behavior of the electron beam in the equipotential drift region. The construction of the gun is described, and experimental formulas are given for calculating the geometric dimensions of the focusing electrode for different perveances of the flux to be shaped. Results of experimental verification are given for two modifications of the proposed electron gun. The authors thank V. A. Solntsev for interest in the work. Figures 6; references: 10 Russian.

[80-6610]

UDC 621.385.832

INCREASING THE SPEED OF CATHODE RAY TUBE SCREENS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 p 229 manuscript received 10 Apr 79

KARAKOZOV, K. G., MIKADZE, A. Z. and KHVINGIYA, V. I., Institute of Cybernetics, Georgian Academy of Sciences, Tbilisi

[Abstract] A method of increasing the speed of a CRT screen is proposed in which light filters are used to eliminate the phosphor emission components that have long afterglow. The technique is based on the fact that the afterglow of certain types of phosphors depends on wavelength. The appropriately selected light filter is placed on the outside of the screen backing and cuts out the spectral components with the longest afterglow. Tests on a screen with speed of 21.5  $\mu$ s showed that a light filter can improve speed to 6.4  $\mu$ s. References: 3 Russian. [62-6610]

UDC 621.385

ANALYSIS OF INTERACTION PROCESSES IN THE DEMATRON

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2169-2179 manuscript received 9 Oct 78

SHIRSHIN, S. I., BAYBURIN, V. B. and IVANOVA, L. N.

[Abstract] The "large particle" method is used for numerical modeling of the self-modulation mode in a magnetron amplifier of the dematron type. On the basis of a two-dimensional model of the interaction space, assuming that edge effects and relativistic phenomena are negligible and that only a single spatial harmonic of the rf field with given circular frequency is set up in the transmission line, the authors study the quantitative characteristics of physical processes on all interaction sections lengthwise of the dematron: the change in configuration of the electron cloud, the rf potential, the rf and dc current. The principal output parameters are calculated: rf power, gain, efficiency and anode current. It is shown that a stepwise change in the magnetic field leads to appreciable improvement of

gain in the dematron. A theoretical explanation is given for the reasons that certain experimental techniques have been effective in improving the output parameters of the dematron. Figures 9; references 15: 8 Russian, 7 Western (2 in translation).  
[80-6610]

UDC 621.385.6

#### INVESTIGATION OF THE SPACE CHARGE FORCE ON THE GROUPING OF ELECTRONS IN THE DRIFT TUBE OF A GYROKLYSTRON

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1928-1935  
manuscript received 30 Jul 79

KURAYEV, A. A. and STEKOL'NIKOV, A. P.

[Abstract] It is shown that an important factor which determines the level of electron grouping in a drift tube is the correct choice of the geometrical parameters of the relative radius of the drift tube and the relative radius of guiding centers in the electron flux, which provides a sufficient reduction of the effect of the dynamic components of the space charge field. In the case of a uniform magnetostatic field, two-dimensional theory gives correct results up to currents  $I_0 \sim 20$  A. In a nonuniform magnetostatic field, the role of the longitudinal forces of the space charge is substantially increased and the limiting currents, with which the two-dimensional theory can still be used, are considerably reduced. Because of the effect of the space charge force, the phase bunch of electrons has a complex form; and a substantial increase of the dynamic spread of the electron velocities. With large currents the theory of grouping proves to be inapplicable. Figures 2; tables 3; references 8: 7 Russian, 1 Western.



## OPTIMIZATION CRITERIA AND THE SHAPE OF THE ELECTRON BUNCH IN A FLOATING-DRIFT KLYSTRON

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1936-1944  
manuscript received 4 Jul 79

KOCHETOVA, V. A., MALYKHIN, A. V. and PETROV, D. M.

[Abstract] Criteria are considered for an optimum regime of bunching of the electron flow and the efficiency of withdrawal of energy from it. An investigation made of the distributions of velocity and the density of electrons in bunched flow made it possible to establish that during forming of an optimum bunch with regimes close to the highest attained efficiency, the maximum amplitude of the first harmonic of the current and the minimum spread of the velocity of the electrons (or the minimum velocity) are not decisive, and the increasing distribution of velocities with respect to the phases of the arrival at the optimum "flying together" bunch is completely determined. Figures 5; references 9: 7 Russian, 2 Western.  
[68-6415]

## INVESTIGATION OF TRAJECTORIES OF ELECTRONS IN A PULSED MAGNETRON UNDER PREGENERATION CONDITIONS

Gor'kiy IZV. VUZ: RADIOFIZIKA in Russian Vol 23, No 8, 1980 pp 986-991 manuscript received 26 Dec 79

BELIAKOV, A. V., GROSHKOV, L. M. and KUZNETSOV, M. I., Gor'kiy State University

[Abstract] As a continuation of research on the formation of an electron cloud in pulsed magnetrons, a study was made of the trajectories of electrons under pregeneration conditions by supplying to the anode of a magnetron diode square and sawtooth voltage pulses with various durations of the leading and trailing edges. The magnetron diode was probed by means of a longitudinal electron beam. The electrooptical method of investigation of trajectories employed is described in detail in an earlier study (1961). The radius of the tube's anode was 32 mm and of its cathode 9 mm. The longitudinal dimensions of the tube were selected so that the transit time of electrons of the probing beam in the magnetron with the required values of the acceleration voltage would be approximately equal to the time for an electron emitted from the magnetron's cathode to reach the peak of the trajectory loop. The optimal length of the tube equaled 110 mm for an acceleration voltage of the probing beam on the order of 2 to 3 kV, an anode voltage of 1.5 to 2 kV and a magnetic field equal to 1.2 to 1.3 times the critical value of 110 to 135 Gs. The design of the electron gun, the structure of the fluorescent screen and the window for observing

trajectories on the screen are described in the earlier study. A test of the electrooptical system demonstrated that by means of the tube used it is possible to obtain reliable information on the motion of electrons in a magnetron. Some results are given of observation of the trajectories of electrons in a magnetron with a hot cathode in the pulsed operating mode. Photographs are shown of curves which describe the probing beam on the screen with the different kinds of voltage pulses supplied to the anode. In all cases the dimensions and shape of the curves are approximately the same. The shape of the curves testifies that the electrons in the magnetron move along loop-shaped trajectories. This holds true both in the case of a relatively rapid increase in anode voltage and with a slower increase. The time for establishing the steady state of the electron cloud, 3  $\mu$ s, is only slightly longer than the duration of the square pulse and the rise time of the sawtooth pulse. The magnetron was probed with a constant anode voltage in order to compare the trajectories of electrons in a magnetron in the pulsed and continuous modes. Fluctuation fields in an electron cloud which result in spreading of the probing beam are stronger with constant voltage than in the case of pulses whose duration is comparable with the stabilization time for the steady state of the electron cloud in the magnetron. With long stabilization times when an irregular section of the electron cloud lying above the radius of the static cloud is not able to form or the duration of the anode voltage pulse, the trajectories of electrons agree satisfactorily with those determined by calculation, employing the theory of a double-flow static state. Figures 3; references 5: 4 Russian, 1 Western.

[37-8831]

## INFRARED

UDC 535.853

### AN ILLUMINATING ATTACHMENT WITH CRYOSTAT FOR A SINGLE-BEAM INFRARED SPECTROMETER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 235-237  
manuscript received 11 Apr 79

BILEN'KIY, B. F. and DANILYUK, Yu. V., L'vov State University

[Abstract] An illuminator attachment for an infrared single-beam spectrometer is described that measures coefficients of transmission and reflection of solids in the temperature range of 90-600 K when a mirror optical system is used that produces an intermediate reduced image of a globar [infrared radiation source] on the crystal holder of a cryostat installed in the illuminator complex. The angle of incidence of the light beam on the specimen in reflectivity measurements is  $5^\circ$  or less. Spectra of reflection and transmission obtained with the device are given. Figures 2; references: 1 Russian.  
[62-6610]

INSTRUMENTS, MEASURING DEVICES AND TESTERS,  
METHODS OF MEASURING, GENERAL EXPERIMENTAL TECHNIQUES

UDC 53.082.5:535.511

A LASER ELLIPSOMETER FOR STUDYING UNSTEADY PROCESSES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 188-190 manuscript received 12 Feb 79

BILENKO, D. I. and DVORKIN, B. A., Scientific Research Institute of Mechanics and Physics, Saratov State University

[Abstract] An ellipsometer is described that contains devices for measuring the time dependence of the azimuth of linear polarization  $\Psi$  and the phase difference between the orthogonal components of polarized radiation. A laser beam reflected from the test specimen is split three ways, sent through polarizers with the azimuths of the axes of maximum transmission at  $45^\circ$ ,  $90^\circ$  and  $0^\circ$  to the plane of incidence on the specimen, and the polarized beams then fall on three photoelectric pickups. The output signals from the photocells are amplified, detected and recorded for further analysis in order to determine  $\Psi$  and  $\Delta$ . Experiments on using the device for studying the process of gas-transport deposition of  $\text{SiO}_2$  layers in Si-SiO<sub>2</sub> structures showed the feasibility of using such an instrument for determining the thickness of the layer, optical properties and their variation, optical constants of the substrate at different growing temperatures and so on. Real-time studies can be done by interfacing with a computer, which could be a basis for automating control of the technological process of deposition. Figures 3; references: 2 Russian.

[62-6610]

## A DEVICE FOR MEASURING ANGULAR MISALIGNMENTS OF PRISMS

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 9, Sep 80 pp 38-40

DUDKA, V. V., BURTSEV, V. N. and MEL'NICHENKO, V. I.

[Abstract] The angles of prismatic elements used in optical devices are usually checked visually by autocollimation or goniometric methods. The authors propose an optoelectronic device for checking angular misalignments of prisms with higher productivity than visual methods with future capabilities for automation. In the optical part of the proposed system, a special illuminator including fiber-optics and prism elements is used to send uniform scattered luminous flux to one face of the right-angle prism to be tested. A light shade in the path of the flux produces a sharp boundary between the light and dark sections. The refracted flux leaving the prism is formed into a magnified image on a flat metal disk with radial holes 0.2-0.3 mm in diameter that is rotated by an electric motor. An opaque shield interrupts the light beam before it hits the plate, dividing the flux into two equal parts in such a way that small deviations of the angle of the test prism from  $90^\circ$  displace the image of the light-contrast pattern relative to the shield by an amount  $\pm \Delta X$ . As the disk rotates, light-shade pulses are produced with a duty factor of 1/2. The geometry of the system is such that the linear displacement  $\pm \Delta X$  corresponds to a change in pulse duration by  $\pm \Delta t$  determined by the change in misalignment angle  $\Delta \phi$ :  $\pm \Delta t_{\min} = \pm k \Delta \phi$ , where  $k$  is a factor that accounts for the resolution of the optical system and the electronics. The light pulses are incident on a photomultiplier, the output signal is amplified, converted to a unipolar square-pulse signal, integrated and read out on a digital display. Output response is linear over a range of  $90^\circ \pm 6^\circ$  with an error of no more than 6". Figures 3; references 4: 3 Russian, 1 Western.

[63-6610]

## THE PT-1 GENERAL-PURPOSE INSTRUMENT FOR MEASURING AND REGULATING LOW TEMPERATURES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 p 241 manuscript received 15 Jan 79

LOGVINENKO, S. P., RUDENKO, B. G., SHAKIROV, R. G. and MEZENTSEV, V. P., Physico-technical Institute of Low Temperatures, Khar'kov

[Abstract] The proposed device measures, controls and stabilizes temperatures over a range of 1000 K in cryogenic research facilities. Operation is based on converting the voltage from a thermometer supplied with stable working current to the digital equivalent of temperature. The regulation is by proportional control with respect to deviation of a given parameter. A memory device enables input of



thermometric data from various types of temperature sensors in five channels. Resolution is 0.01, 0.1 and 1 K respectively in ranges of 1-10, 10-100 and 100-1000 K. Measurement data are displayed in digital or analog form and can be fed directly to a computer for further processing. The instrument measures 400 x 470 x 240 mm and weighs 19 kg. Technical characteristics are stable at ambient temperatures from +5 to +50°C and relative humidity up to 80%. Figures 1.  
[62-6610]

UDC 539.1.074.9

#### A COORDINATE GAS DETECTOR OF ULTRAVIOLET AND X-RAY PHOTONS WITH R-F FIELD

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 203-206  
manuscript received 28 Mar 79

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[Abstract] Investigation of vacuum ultraviolet and x-ray emission of plasma discharges requires a coordinate detector with resolution of about 1 mm. In a previous design [see Yu. V. Dubrovskiy, V. D. Peskov, "Pribory tekhnika i eksperimenta," No 3, 1979, p 65] a G-M counter was used with anode filament wound into a flat coil. However, the Geiger discharge propagates to a limited distance, so that the working area cannot be increased beyond 20 x 20 mm. This paper describes an improved detector with working area nearly two orders of magnitude larger. The counter is made up of two flat well polished copper electrodes between which a radio-frequency field is applied with strength of  $10^4$ - $10^5$  V/cm. The electrodes are coated with a dielectric in order to prevent false counts at high field strengths. When the gas in the counter is photo-ionized, the primary electrons that are formed oscillate under the action of the r-f field. Since the frequency is high, the amplitude of the oscillations is less than the distance between electrodes, so that the electrons remain in the counter for several periods of the r-f field, accumulating energy and exciting atoms and molecules of the gas. The emission of these excited particles generates new electrons, and an ionization wave accompanied by luminescence propagates from the point of absorption of the primary photon. The rate of propagation of this wave to the photomultiplier is nearly constant, so that the coordinate of the primary photon can be determined from the time of delay of arrival of the wave at the ends of the electrode. Coordinate resolution of the counter is about 2 mm, and time resolution is a few microseconds. The author thanks P. L. Kapitsa and G. D. Bogomolov for discussing the work. Figures 3; references 5: 4 Russian, 1 Western.  
[62-6610]

## A WIDE-BAND SYNTHESIZER OF TIME INTERVALS AND REFERENCE TIME SHIFTS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 p 251 manuscript received 12 Feb 79

YEFREMENKO, D. A., LUTKOVSKIY, V. M. and MALEVICH, I. A. Laboratory of Analog-Digital Measurement Methods, Scientific Research Institute of Applied Physics Problems Affiliated with Belorussian State University

[Abstract] A synthesizer is proposed for shaping a grid of discrete reference time intervals with high stability of limit setting, and also discretely controllable time shifts of signals of special shape. The device is based on the principle of multilevel shaping of controlling and gating signals from which a discrete grid of time scales is selected. The reference pulse sources are two oscillators with periods of 12.5 and 100 ns having single-loop and multiple-loop delayed feedback. The synthesizer has working bands of 0-125  $\mu$ s, 280-405  $\mu$ s and 5-50 ms. Measurements are 480 x 420 x 200 mm and weight is 15 kg. Figures 1. [62-6610]

## OPTICAL METHODS OF CHECKING THE SHAPE OF SURFACES

Moscow IZMERENIYA KONTROL' AVTOMATIZATSIYA in Russian Nos 3-4, 1980 pp 8-17

DUKHOPEL, I. I., candidate of technical sciences, and SIMONENKO, T. V., engineer

[Abstract] Only the most important methods are discussed for production process and approval checking of the correctness of the shape of flat, spherical and cylindrical surfaces and aspherical surfaces of revolution. The methods of checking are discussed on the basis of the equipment used to implement them. All optical methods of checking flat and other kinds of surfaces are divided into two groups: contact and noncontact. The former are used primarily for checking surfaces with a relatively coarse microstructure and articles with high hardness, whereas the latter are used mainly for checking surfaces with a fine microstructure and articles with low hardness. Surfaces with a fine microstructure reflect a high percentage of unscattered light when exposed to a light source. Contact methods are largely intended for checking products of the machine building and instrument making industry and they include the use of visual and photoelectric autocollimators, telescopic sights, optical rules and strings, flatness gauges, and, in the optical and instrument making industries, test glasses. The key technical characteristics are presented for autocollimators and telescopic sights. One autocollimator listed, the AF-1Ts, is photoelectric and can read in divisions of 0.1 and 0.2 minutes of angle. Optical rules, optical strings and flatness gauges represent a new generation of instruments in considerable demand. They make possible greater measurement accuracy and more complete information on the surface being studied and are simpler to use and lend

themselves more easily to automation than do autocollimators and telescopic sights. The newest of these instruments have been supplied with systems for automatically recording measurement results. The basic optical-mechanical diagram is given for a rule which is read visually. Its basic components are two coaxial reflex-lens objectives along whose axis moves, on rollers, a carriage inside of which is a feeler to which is rigidly connected a small block with a light-dividing face and a mark, the latter of which is illuminated by a lamp by means of a system of optical elements. The light passes through the reflex-lens objectives and an image of the mark is projected onto a screen. When the mark moves up its image moves the same distance down, and vice-versa. The carriage is moved along the surface, the mark is moved by uneven places on the surface, and the deflections of the mark are recorded. In the IS-49 rule the visual channel has been replaced by a photoelectric one and deviations from straightness of the surface are recorded automatically. The basic optical-mechanical diagram is given for a type DP-477 optical string. This instrument eliminates a serious disadvantage of the majority of telescopic sights--the error from nonlinearity of the movement of the focusing element. This instrument consists of a mark element and a telescopic sight and employs a reference microscope. The mark element contains a point diaphragm and measurements are made of the amount of deviation of the image of the diaphragm from the axis of the reference microscope. On the basis of the DP-477 have been developed the OS-3M general-purpose optical string and IS-41M2 and OP-1 flatness gauges. The OP-1 flatness gauge differs from the DP-477 optical string mainly in that the telescopic sight element is placed on a standard reference flat in the form of a precisely machined pyroceramic disk. The key technical characteristics of optical rules and strings and flatness gauges are given in a table. Listed as chief among noncontact methods are those of interferometry. A Fizeau interferometer is described. Discussed individually are the checking of spherical, aspherical and cylindrical surfaces. The key characteristics are given for instruments for checking spherical surfaces, which include the IZK-58M, IT-148 and IT-154 instruments. A diagram is given of a polar aspherometer and of a two-wave interferometer. With regard to automation, at the present time there are very few automated optical instruments for checking the shape of surfaces for large-scale practical application. Figures 9; tables 6; references 46: 29 Russian, 17 Western.

[41-8831]

# USING BOLOMETRIC CONVERTERS TO COMPARE MICROWAVE POWER STANDARDS WITH STANDARDS FOR THE SPECTRAL DENSITY OF MICROWAVE POWER

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 9, Sep 80 pp 58-59

MEKHANNIKOV, A. I., PETROSYAN, G. G. and RESHETNIKOV, O. M.

[Abstract] The Soviet State standard of the microwave power unit in the cm band reproduces the power unit in a dynamic range of  $10^{-3}$ - $10^{-2}$  W at frequencies of 2.59-37.5 GHz, and is based on a calorimetric method of comparing the measured microwave power with known DC power. The standard for the unit of spectral density of microwave power reproduces this unit on a level of  $6.3 \cdot 10^{-21}$  W/Hz and on a level of  $3 \cdot 10^{-19}$  W/Hz at frequencies of 1-37.5 GHz, and is based on the theory of blackbody emission. Comparison of the two standards is based on the results of studies of the noise properties of waveguide bolometric converters, which can be used both as power meters and as thermal noise generators. In power measurement, the microwave power absorbed in the bolometers is replaced by a DC substitution power  $P_{sub} = P_{in}A\eta$ , where  $P_{in}$  is the power input to the bolometric converter,  $A$  is the coefficient of absorption of the converter, and  $\eta$  is the conversion factor defined as the ratio of the microwave power absorbed by the bolometers to the total microwave power absorbed in the bolometric converter. When the converter operates as a thermal noise generator, the surplus effective noise temperature at the output is  $\Delta T_{out} = \Delta T_b A \eta$ , where  $\Delta T_b = T_b - T_a$ ,  $T_b$  is the temperature of the bolometers,  $T_a$  is ambient temperature. The values of  $P_{in}$  and  $\Delta T_{out}$  can be measured by the unit standards, while  $P_{sub}$ ,  $A$  and  $\Delta T_b$  can be accurately determined by other methods. In this way the coefficient  $\eta$  can be found from the two formulas, and the measurements can be taken as collation of the standards with respect to  $\eta$ . Experimental verification shows that the proposed method of comparison is feasible. Tables 1; references 7: 6 Russian, 1 Western. [63-6610]

UDC 621.317.7

# A LOW-CURRENT SOURCE FOR NONDESTRUCTIVE INSPECTION OF METAL-DIELECTRIC-SEMICONDUCTOR STRUCTURES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 220-221  
manuscript received 6 Feb 79

SAL'MAN, Ye. G., SAMOYLOV, V. A. and VERTOPRAKHOV, V. N., Institute of Inorganic Chemistry, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] The stability of devices based on MDS structures depends on the quality of the dielectric layer. One cause of instability is migration of alkali metal and hydrogen ions. One method of determining this factor is to examine the displacement of the capacitance-voltage curve under the action of an electric field and



heating, and the spectrum of thermostimulated polarization or depolarization currents. However, such methods require heating and cooling of the MDS structures, which makes them time-consuming. It has been suggested that the properties of a dielectric layer could be checked by observing the change in voltage across the MDS structure as a direct current is passed through. This paper describes a source of weak current that can be regulated over a wide range. The proposed circuit is a voltage amplifier in which a difference amplifier is used to compare current feedback voltage to a reference voltage. The source produces stable current at an output voltage of 0-150 V. Controllable current range is from  $10^{-11}$  A to  $3 \cdot 10^{-6}$  A. An initially shorted MDS structure is supplied with current from this source so that its capacitance begins to charge. As long as the conductance of the dielectric layer is low, the structure continues to act as a fixed capacitor and the voltage across it changes linearly, with time until the dielectric layer loses its insulating properties. The corresponding voltage is a characteristic of the quality of the dielectric layer. Figures 2; references 4: 2 Russian, 2 Western. [62-6610]

UDC 612.317.7.088.7

#### AUTOMATED MEASUREMENTS IN THE TIME REGION AND IMPROVING THEIR ACCURACY

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 9, Sep 80 pp 42-44

ANDRIYANOV, A. V., GLEBOVICH, G. V., KRYLOV, V. V., KORSKOV, S. Ya. and PONOMAREV, D. H.

[Abstract] The authors discuss the problems of measurements in the time region in pulse reflectometry when pulses of picosecond duration act on the research object with a frequency spectrum from a few Hz to tens of GHz. A simplified block diagram is given of an automated system for measurements in the time region. In such a system the processed signal is stored in a computer and can be observed on a display screen or printout. Depending on the application, the automated system may use generators that produce a voltage differential with amplitude of 15 V and rise time of 70 ps, a video pulse with duration of 60 ps and amplitude of 3 V, or nanosecond radio pulses in the 2-4 and 8012 GHz bands with pulse power of 100 mW. Such facilities can be used to measure the frequency response of radio equipment up to 10 GHz, the dielectric and magnetic spectra of materials, the parameters of antenna-feeder channels, the radiation patterns and frequency responses of antennas without using anechoic chambers, the parameters of transistors and amplifiers in both the time and frequency regions, and the concentrations of solutions. Sources of errors and methods of reducing them are considered. Figures 3; references 11: 9 Russian, 2 Western. [63-6610]



## AN AUTOMATIC INSTRUMENT FOR MEASURING STATIC CHARACTERISTICS OF LOW-NOISE TRANSISTORS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 p 240 manuscript received 22 Mar 79

ATAMALYAN, E. G., PETRENKO, V. V. and POLTAVETS, V. P., Department of Electrical Engineering, Moscow Engineering Physics Institute

[Abstract] The proposed instrument is designed for DC measurements of n-p-n and p-n-p transistors. A digital printer records the input and output characteristics of the transistor in a common-emitter circuit, the voltage on the collector of a saturated transistor, the inverse current in the collector circuit, and the current-transfer ratio of the base in a common-base circuit. Provisions are made for automatic control by programmable current and voltage sources. The printout has 16 places: 8 places show the assigned characteristics, and 8 places give the results of measurements. Discrete voltages can be set from 0.1 to 30 V, and discrete currents can be set from  $10^{-6}$  to  $2 \cdot 10^{-3}$  A. The base current-transfer measurements are accurate to 5% in a range from 1 to 300. Voltage across the collector of a saturated transistor is measured in a range from  $2 \cdot 10^{-2}$  to 1 V at currents of 10, 5 and 2 mA in the collector circuit. The ten channels of the device are sequentially scanned. The unit measures 508 x 420 x 240 mm and weighs 6 kg. Figures 1. [62-6610]

## INFORMATION MEASUREMENT COMPLEX FOR EXPRESS ANALYSIS OF THE OPTICAL STATE OF THE ATMOSPHERE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 p 248 manuscript received 1 Feb 79

IVANOV, V. I., MALEVICH, I. A., SKOMOROSHCHENKO, V. I., BORODAVKO, A. N., LUTKOVSKIY, V. M. and GABRUSEV, V. P., Laboratory of Analog-Digital Measurement Methods, Scientific Research Institute of Applied Physics Problems Affiliated with Belorussian State University

[Abstract] The proposed set of equipment can be used for remote measurements of parameters of the atmosphere at altitudes of 0-35 km by an optical method from a stationary base or moving vehicles, and also for analyzing optically transparent media of different densities. The equipment operates in either the long-range or short-range mode, depending on the intensity of the signals to be analyzed. There are 510 recording channels. The error of determining spatial coordinates on the probing path relative to the coordinates of the emission of the probing pulse is within 0.5 m. The passband of the measurement channel in the photon counting-rate

mode is greater than 50 MHz, and in the analog signal mode--from 200 Hz to 18 MHz. Dynamic range of the analog signal is greater than 80 dB. The equipment is designed around integrated circuitry and semiconductor devices. Dimensions are 490 x 480 x 630 mm. Figures 1.  
[62-6610]

UDC 621.382.3:621.317.32

#### A DEVICE FOR MEASURING THE PARAMETERS OF UNIJUNCTION TRANSISTORS

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 9, Sep 80 p 57

CHIRKOV, V. P. and RED'KO, V. V.

[Abstract] As a rule, conventional methods of measuring the static parameters of silicon double-base diodes require tedious calculations and are inaccurate. This article describes the circuit of a device for such measurements that is both automatic and improves measurement accuracy. The circuit is based on FETs and bipolar transistors and includes a source-follower, an emitter-follower, an amplifier, a flip-flop and a double switch. A reed relay is enclosed in an inductance coil connected in the collector circuit of one of the transistors in the flip-flop. The unijunction transistor is connected between the emitter-follower and amplifier, and readout is by a voltmeter and milliammeter connected in its emitter circuit. Setting the double switch in one position gives the values of the firing voltage and current, and setting it in the other position gives the drop-out values of the current and voltage. Figures 1; references: 1 Russian.  
[63-6610]

# A FACILITY FOR MEASURING THE FREQUENCY RESPONSE OF INFRARED PHOTOCELLS IN THE RANGE OF 0.03-1 GHz

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 186-187  
manuscript received 6 Feb 79

BIRYULIN, P. V. and VOLOBUYEV, M. I.

[Abstract] Measurement of the frequency responses of a photoelectric pickup over a wide frequency range requires the use of several oscillators and measurement receivers with subsequent matching of the results on the edges of sub-bands. This paper describes a measurement facility that simplifies such measurements. The device is based on the ML-7 modulator with GaAs crystal 100 mm long. This modulator was originally designed for frequencies up to 100 MHz, and modifications were made to increase the working frequency. The upper electrode was split into unequal parts, and the DC voltage setting the working point of the modulator was applied to the longer section, while the rf modulating voltage was applied to the shorter section. In operation, infrared light from a CO<sub>2</sub> laser passes through this modulator, and a beam splitter sends part of the transmitted emission to a power meter, and the other part to the pickup whose frequency response is to be measured. The output signal from the pickup is amplified, detected, selectively amplified and measured. Figures 2; references: 3 Russian.  
[62-6610]

# USING THE LD(D) LAMP IN THE WORKING STANDARD OF THE SPECTRAL DENSITY OF RADIANCE IN THE VACUUM ULTRAVIOLET

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 9, Sep 80 pp 40-41

ANEVSKIY, S. I., GREBEN'KOV, V. S., KVOCHKA, V. I., PANASYUK, V. S. and SAMOSHENKOV, Yu. K.

[Abstract] To meet the requirements of energy measurements in the vacuum ultraviolet region, the Soviet Union has developed a special State standard for a unit of spectral density of radiance. The authors discuss the use of the LD(D) deuterium lamp in the working standard, and also in a laboratory facility for measuring the spectral density of radiance in the 0.165-0.25  $\mu$ m band. The LD(D) lamp is of a convenient design for combining with vacuum spectral equipment, has an emitting discharge region 3 mm in diameter with constant luminance over a considerable portion, and uses a grade KU-1 quartz window, enabling complete utilization of the continuous spectrum of the hydrogen molecule for measurements. The working standard

includes the emitter and a spectral radiance comparator. A special optical comparison system is included to compensate for aging of the lamp. The method of comparing the unit of spectral density of radiance of the working standard with laboratory facilities is explained. Laboratory facilities do not include the spectral radiance comparator. Figures 3; references 7: 3 Russian, 4 Western.  
[63-6610]

UDC 681.723.089.6

#### A MEASUREMENT MICROSCOPE WITH PHOTOELECTRIC ORIENTATION ON THE EDGE OF AN OBJECT

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 9, Sep 80 pp 33-35

GOLUBOVSKIY, Yu. M., KULIKOVA, N. I. and PIVOVAROVA, L. N.

[Abstract] The conventional method of determining sizes with a measurement microscope is to use a shadow projection, locating the edge of the image visually, and measuring displacement of the item on the stage. The authors propose a microscope with photoelectric edge locator operating in transmitted light. A narrow light beam is directed through the bottom of the transparent moving stage holding the object to be measured. After passing through the microscope objective lens, the beam of parallel rays goes through a rotatable wedge and a lens that forms an image of the edge of the object in its focal plane. Located in this plane is a diaphragm with a circular aperture beyond which is a photoelectric pickup. Rotation of the wedge displaces the image of the edge of the object relative to the aperture in the diaphragm, giving rise to pulses in the illumination on the photocell. The geometry of the device is such that the rise time and fall time of these pulses is an order of magnitude less than the pulse duration. When the average position of the image falls in the center of the aperture, the duty factor of the pulses is 1/2. A shift to one side or the other increases or reduces the duty factor, which is indicated by a microammeter. A magnified ruled scale is used for displacement readout, giving an accuracy within 0.5  $\mu\text{m}$  on lengths up to 20 mm. An analysis is made of the various error components. Photoelectric edge location increases productivity of measurement operations, and can triple or quadruple measurement accuracy for items of cylindrical type as compared with visual orientation on the edge. Figures 2; references 3: 2 Russian, 1 Western.  
[63-6610]

## ON THE DETECTION OF MILLIMETER WAVE RADIATION BY HALL-TYPE SENSORS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1966-1972  
manuscript received 21 Nov 78

TOLMACHEV, M. M., TRIFONOV, V. I. and NOVICHIKHIN, Ye. P.

[Abstract] Within the limits of a kinetic model a general expression is obtained for the volt-watt response of a Hall-type sensor and numerical evaluations are presented of magnitudes which are of interest in the creation of detectors and mixers of the millimeter band. For a numerical evaluation of the magnitudes of the volt-watt responses, two cases are considered: 1) n-InSb at the temperature of liquid nitrogen; and 2) n-GaAs at room temperature. With the aid of a computer, the dependence is shown of the volt-watt response on the thickness of the semiconductor wafer in the millimeter waveband. A graph is presented of this dependence with various values of the equilibrium concentrations of electron conductivity. It is shown that the basic mechanism of detection in the above cases is caused by the non-uniformity of the field of the system in an infinitely long rectangular waveguide with a semiconductor wafer between wide walls, and is not caused by the Hall effect. The analysis conducted makes it possible to consider the prospects for detection of low levels of the power of electromagnetic radiation. Figures 1; references 20: 18 Russian, 2 Western.  
[68-6415]

## ANALYSIS OF HIGH-ORDER RELAY SYSTEMS BY THE METHOD OF DEGENERATE CYCLES

Leningrad IZV. VUZ: PRIBORSTROYENIYE in Russian Vol 23, No 9, Sep 80 pp 30-35  
manuscript received 11 Apr 79

SIMONOVA, L. V.

[Abstract] A closed-loop system consisting of a relay-type nonlinear element and a multielement linear part is considered and its free motion, without an input signal to the system, is analyzed by the method of point mapping with reduction of the phase space. The relay characteristic is assumed to include an insensitivity zone and a hysteresis. The fundamental differential equation of the system dynamics in operator form is rewritten in the Lur'ye canonical form with two principal phase coordinates corresponding respectively to the zeroth pole and to the pole defined by the largest time constant among those of the system elements. The phase plane is found to consist of three overlapping sheets, the boundaries between them defined by movable switching lines with inclined asymptotes. Two mapping functions which together define the transformation are determined with respect to the asymptotes rather than the switching lines. This simplifies the expressions, eliminates



a numerical solution of a system of nonlinear equations, and qualitatively yields almost the same result. This means that the system has simultaneously an equilibrium position and a single stable limit cycle. Therefore, degeneration and vanishing of a cycle occur at the boundary of the insensitivity zone, so that the criterion of system stability can be described with the parameters of this zone. The paper was recommended by the Department (Kafedra) of Automatic Instrumental Devices, Moscow Aviation Institute imeni S. Ordzonikidze. Figures 3; references: 3 Russian. [71-2415]

UDC 621.317.757

#### MATRIX CIRCUITS IN A SPECTRUM ANALYZER

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 2004-2007  
manuscript received 16 Apr 79

BRUK, Yu. M. and INYUTIN, G. A.

[Abstract] The frequency characteristics are investigated of a matrix spectrum analyzer, a block diagram of which is shown. Included in the analyzer is a bandpass filter with frequency characteristics  $S_0(\omega)$ , a frequency-independent delay line with a delay between the taps  $\tau$ , and a Butler matrix. An experimental investigation was conducted on a 16-ray matrix with a 6--32 MHz band and a quartz 64-tap delay line with a 14--26 MHz band and a total delay of 51.2 microseconds, which provided an analysis band of 17--70 kHz and a Q of 1200-300, respectively. The results presented show the possibility of creating a matrix spectrum analyzer on the basis of the circuit described, with very high parameters and equivalent Qs on the order of 103. Figures 3; tables 1; references 9: 3 Russian, 6 Western. [67-6415]

UDC 681.327.11

#### LATEST DEVELOPMENTS IN DESIGN OF CONTROL ELEMENTS ON FRONT PANELS

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 9, 1980 p 31

PLESKOV, V. A. and FUCHILA, N. T., candidates of technical sciences

[Abstract] A report on the use of soft antifriction elastomers for making control buttons on the front panels of electronic instruments. Some button designs are given and ways of fastening for direct action on board-mounted microswitches. The use of elastomers opens up new capabilities for design of weatherproof portable instruments. Figures 2.

[82-6610]

# MEASURING THE INDUCTANCE OF EDDY-CURRENT PRIMARY TRANSDUCERS OVER A CONTINUOUS HIGH-FREQUENCY RANGE

Leningrad IZV. VUZ: PRIBOROSTROYENIYE in Russian Vol 23, No 9, Sep 80 pp 12-16  
manuscript received 23 Nov 78

FLOROV, A. K. and KHANDETSKIY, V. S.

[Abstract] A dual, measuring and reference, inductive voltage divider is considered which has eddy-current transducers in its upper arms and supplementary inductance coils in its lower arms. It is demonstrated analytically that the insertion inductance caused by a conductor found within the field of this instrument can be measured with it, by the output voltage ratios, over a continuously swept high-frequency range. The instrument error, absolute and relative, as well as the indeterminacy zone are calculated taking into account the conversion sensitivity and linearity characteristics. Ideal elements are assumed, with an infinitely high Q-factor. Changes in the transducer self-inductance and in the ratio of coil inductance to transducer inductance caused by the skin effect and caused by the proximity effect are left to experimental determination. The effect of resistances in the elements is evaluated theoretically and the necessary correction is found to be small. An experimental study with aluminum and copper conductors in the field has established that the amplitude-frequency characteristic of this divider does not depend on the frequency of the supply current over a wide range of Q-factor values down to very low ones. The paper was recommended by the Department (Kafedra) of Electronic Computing Machines, Dnepropetrovsk University imeni Tercentennial of the Union between Ukraine and Russia. Figures 3; references: 3 Russian.  
[71-2415]

# EXPERIMENTAL INVESTIGATION OF THE FIRST HARMONIC PHASE OF A LIGHT WAVE TRANSMITTED THROUGH AN ULTRASONIC BEAM

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1991-1994  
manuscript received 3 May 78, after revision 28 Jan 80

ZILBERMAN, G. Ye., KUPCHENKO, L. F. and ZHUKOV, S. S.

[Abstract] The phase characteristics are experimentally investigated of the central diffraction harmonic  $\psi_0$  at the output of the test piece (i.e., with  $x=l$ ) with various angles  $\theta$ . The results of the experiment are compared with the theory developed in a 1979 work by Zilberman and KUPCHENKO in which it was assumed that the amount of change in the refractive index  $n_0$  in an ultrasonic wave is constant along the front of the acoustic wave. A Jamin interferometer served as the basic experimental device. Figures 2; references 3: 2 Russian, 1 Western.  
[68-6415]

## A MAGNETIC FIELD SENSOR

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 9, 1980 p 28

YEGIAZARYAN, G. A., candidate of physicomathematical sciences, and SARKISYAN, A. S., engineer

[Abstract] The low output amplitude of conventional magnetosensitive devices makes it necessary to add amplifiers to boost the signal. The authors propose a magnetoresistive instrument based on the KD304 magnetodiode that produces a signal strong enough to be used without additional amplification. The KD304 diode is a high-sensitivity magnetosensitive semiconductor that works on the principle of a controlled lifetime of injected carriers by an external magnetic field. Structurally, the device is a plate with two active junctions separated by a high-resistance semiconductor region with thickness of several diffusion lengths of the current carriers. To maximize the output signal, the magnetodiode is placed so that the magnetic lines of force are perpendicular to the side faces of the plate. At an induction of 0.3 T, the voltage magnetosensitivity is 60-80 V/T at a current of 3 mA, and the current magnetosensitivity is 10-20 mA/T at a voltage of 10 V or more. Thus the device is about three orders of magnitude more sensitive than Hall generators and magnetoresistors used as magnetic field sensors. Figure 1.

[82-6610]

QUALITY CONTROL AND CONTROL OF THE PROCESS OF MICROWELDING AND SOLDERING OF INTEGRATED CIRCUITS FROM ACOUSTICAL CHARACTERISTICS OF THE JOINT

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian No 1, 1980 pp 134-135 manuscript received 1 Nov 77

KOLESHKO, V. M. and GULAY, A. V., Belorussian SSR Academy of Sciences Institute of Electronics

[Abstract] The annotation is presented for an article deposited at VINITI [All-Union Institute of Scientific and Technical Information], registration No 934-78 Dep., dealing with the employment of acoustical methods for testing microwelded and soldered joints in integrated circuits. A brief description is given of the principles of the following methods of acoustical testing: acoustical sounding of the joint zone, employing reflected echo signals; through sounding of the joint zone, whereby the quality of a microwelded joint is judged by the rate of attenuation of ultrasonic pulses repeatedly reflected from the external surfaces of the joined elements; testing in terms of the amount of mechanical input impedance of the joint zone; testing in terms of acoustic power, whereby the nature of the change in acoustic power absorbed during ultrasonic microwelding in a contact is determined by the acoustic impedance of the contact; testing by means of the acoustical holography method, whereby an acoustic hologram is formed by adding to the electrical signal of a generator the signal from the output of a detector which converts phase modulation of a laser beam reflected from the surface into amplitude modulation; and testing by the acoustical emission method, whereby the total energy of acoustical emission is measured, or the number of pulses per unit of time, with processing of the signal by the selection of pulses by amplitude or frequency. References: 7 Russian. [42-8831]

LIGHT-VALVE SYSTEMS WITH A LASER AS THE LIGHT SOURCE

Leningrad IZV. VUZ: PRIBORSTROYENIYE in Russian Vol 23, No 9, Sep 80 pp 77-80  
manuscript received 11 Apr 79

KHVALOVSKIY, V. V., NATAROVSKIY, S. N. and FEDOROV, Yu. V.

[Abstract] The use of lasers rather than high-power thermal light sources is considered in light-valve systems for visualization of nonabsorbing objects. A laser eliminates heating and reduction of the contrast, but the resulting granular image consisting of "wild" points is of lower quality. Diffusion of the laser light by means of scatterers such as frosted glass or fluids with suspended random moving particles reduces the coherence and thus also the contrast. A better method of reducing the image granularity is placing a lenticular raster in the valve projector system. It can be placed directly before the laser, followed by a collector lens and a converging lens, from where the light passes through the object, the objective lens, and a stop to the screen. In other variants the raster is placed between the collector lens and the converging lens, or the collector lens can be eliminated with the raster taking over its function. The paper was recommended by the Department (Kafedra) of the Theory of Optical Devices, Leningrad Institute of Precision Mechanics and Optics. Figures 4; references: 3 Russian, 1 Western (in translation). [71-2415]



# NUMERICAL AND ANALYTICAL CALCULATIONS OF PARAMETERS OF TWO-CONDUCTOR PLANAR STRUCTURES FOR WAVEGUIDE ELECTROOPTICAL MODULATORS

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian  
No 1, 1980 pp 113-118 manuscript received 12 Jul 79

KOVALEV, I. S., LUKASHEV, V. M. and SOLONOVICH, I. F., Belorussian SSR Academy of Sciences Institute of Electronics and Belorussian SSR Academy of Sciences Division of Physics of Nondestructive Testing

[Abstract] Waveguide electrooptical modulators are not widely used because of the lack of precise and universal methods of calculating their design parameters. Procedures are presented here for making numerical and analytical calculations of such parameters of two-conductor planar structures as line capacitance, wave impedance, phase velocity and attenuation of modulating waves by employing the methods of finite differences and transformation in complex planes. The assumption is made that a quasi-TEM wave is propagated in the modulator. A solution is found to the Laplace equation in the plane of the modulator's cross section including two regions--an isotropic and anisotropic, the latter represented by the crystal. The Laplace equation for an anisotropic medium with assigned boundary conditions is solved by the method of finite differences. Calculations were performed by Libman's speedy iteration method (1971) for determining the value of the potential at a point in an anisotropic dielectric. From this value are determined values of the potential at net points situated in an isotropic medium. An equation is given for the potential at points lying at the isotropic-anisotropic dielectric boundary. The charge per unit of length is calculated according to the Ostrogradskiy-Gauss theorem. Equations are presented for the capacitance per unit of length, the wave impedance and phase velocity. A flow chart is presented for a program for calculating the parameters of electrooptical modulators. On a YeS-1022 computer calculations were made, by using this program, of line capacitance, wave impedance and phase velocity for electrooptical modulator structures containing class-3m trigonal-system crystals of lithium niobate and tantalate. The method of transformations in complex planes was selected as a general approach to an analytical solution to the problem, because this is one of the most effective methods for an analytical solution for two-dimensional fields. Calculations were made of the line capacitance and wave impedance of two-conductor planar structures utilizing lithium tantalate and niobate for different values of the form factor. Calculations were compared with published data obtained by approximation methods; the accuracy of the analytical solution for capacitance and wave impedance equaled 15 percent over the range of variation of the ratio of structural parameters (width/length) from 0.1 to 3.0. For the purpose of determining the attenuation factor resulting from losses in conductors a method was employed based on the principle of a change in the intrinsic induction resulting from an infinitesimally small increase in the conductors. Calculated dependences of the attenuation factor on the geometrical dimensions of the waveguide are shown, and equations are given for the attenuation factor resulting from dielectric losses and from radiation. It is demonstrated that the combined use of numerical and analytical methods makes it possible to conduct a thorough analysis, with the required accuracy, of the basic parameters of two-conductor planar structures required for designing electrooptical modulators. Figures 3; references 8: 4 Russian, 4 Western. [42-8831]

## DISPLACEMENT THRESHOLD AS A PERFORMANCE CHARACTERISTIC OF MECHANISMS IN OPTICAL DEVICES

Leningrad IZV. VUZ: PRIBOROSTROYENIYE in Russian Vol 23, No 9, Sep 80 pp 80-84  
manuscript received 28 Feb 79

KNOROV, I. V.

[Abstract] Kinematic mechanisms in optical devices can be divided according to their function into control mechanisms and measuring ones. Here the class of positioning control mechanisms is examined in terms of performance, in a search for a definitive quality criterion for their design. Two modes of positioning control are possible, either with the exposed reference element to be covered or with the covered reference element to be exposed during the process. The concept of "displacement threshold" is defined for this class of mechanisms, in terms of contrast and the possibility of the object passing through the field of sharp vision unnoticed--depending on the relation between displacement speed and sensing speed. This concept is also extended to measuring mechanisms, which generally convert a small "signal" displacement to a larger one. In this case the displacement thresholds raise the overall sensitivity threshold, equal to the null error, and the accuracy of realizing the transfer function is just as important in the design as establishing the threshold displacement. The paper was recommended by the Department (Kafedra) of Optical Devices Design and Production, Leningrad Institute of Precision Mechanics and Optics. Figures 3; references: 7 Russian.  
[71-2415]

## OPTIMUM DESIGNS OF MAGNETIC DEFLECTIONS IN ELECTRON-OPTICAL SYSTEMS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2189-2194  
manuscript received 10 Sep 79

DODIN, A. L. and NESVIZHSKIY, M. B.

[Abstract] Some of the coefficients of aberrations of an electron-optical system that arise with operation of the deflecting system exist only when there is a third harmonic in the expansion of the scalar potential in a Fourier series with respect to the angular coordinate. Because the third harmonic of the potential plays no part in deflection of the electron beam, a deflecting element is needed that has no such harmonic, i.e., a cosine-law deflecting element. The authors suggest a procedure for designing such a deflecting system and find conditions that must be satisfied to convert saddle-shaped, stator and toroidal deflecting elements to cosine-law systems. It is shown that multiple-turn coils can be used to get a zero third harmonic in such deflecting systems without using correcting networks. Figures 5; references 5: 1 Russian, 4 Western.  
[80-6610]

## QUANTUM RECEPTION OF DISCRETE PHASE-MODULATED SIGNALS IN THE OPTICAL BAND

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2088-2098  
manuscript received 24 Oct 77, after revision 12 Mar 79

DERYUGIN, I. A., KURASHOV, V. N. and MASHCHENKO, A. I.

[Abstract] A comparative analysis is made of the sensitivity of systems of coherent optical reception with different characteristics of the transmission channel. Discrete quantum channels of zero-beat and coherence-difference type are optimized with respect to an information criterion. The operation of such devices is considered in the weak-signal approximation when quantum effects of the photoregistration process are predominant. Characteristic regions of maximum efficiency of the given systems of phase demodulation are defined for some special cases, and it is shown that under conditions of multiplicative phase interference the coherence-difference system gives an appreciable gain in efficiency with respect to the information criterion. Figures 4; references 10: 9 Russian, 1 Western.

## EVALUATION OF SPATIAL-DENSITY-VERSUS-CONTRAST CHARACTERISTICS OF MICROCHANNEL PLATES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 8, Aug 80 pp 1745-1750  
manuscript received 19 Jul 79

ZANODVOROV, N. P., ZOLINA, N. K., TYUTIKOV, A. M. and FLEGONTOV, Yu. A.

[Abstract] Microchannel plates are used to intensify the brightness of a two-dimensional image in second-generation electrooptical converters. They make it possible to intensify brightness by a factor of  $10^3$  to  $10^4$  with a theoretical geometrical resolution in all directions of  $N_g = 1000/2D$ , where  $D$  is the distance between the centers of the electron multiplier channels. However, with low  $d(D)$ , where  $d$  is the diameter of a channel, this resolution is not achieved. The quality of a microchannel plate system is evaluated by its spatial-density-versus-contrast characteristic, representing the dependence on the spatial density of the coefficient of transfer by the system of the contrast of an image of a sinusoidal optical focusing pattern. The resolution achievable by a system is defined as the spatial density with which the image contrast is reduced to a level still detectable by the eye, i.e., three to five percent. Here a method is developed for calculating spatial-density-versus-contrast characteristics of a microchannel plate system from experimentally measured distributions of electrons exiting from the channels in terms of direction and energy. A microchannel plate--flat field--screen system is analyzed. Lack of perfection of the fabrication technology for microchannel plates, particularly in terms of ensuring channels of equal diameter, results in the fact that

electrons exiting from channels do not have the same directions and energy, which results in the intense scattering of electron flux in the gap between the microchannel plate and the electroluminescent screen. The calculations presented use the data of an earlier study (1979) devoted to measuring precisely these distributions. The maximum achievable characteristics calculated represent a considerable improvement over those observed in real systems and appearing in the published data. This is attributed particularly to the difference in the diameters of channels resulting from imperfect technology. Figures 4; references 7: 5 Russian, 2 Western.  
[44-8831]

## OSCILLATORS, MODULATORS, GENERATORS

UDC 621.373.5

### ON THE SYNCHRONOUS OPERATION OF SELF-OSCILLATORS COUPLED BY MEANS OF A POWER RING-TYPE ADDER

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1904-1908  
manuscript received 2 Apr 79

NOVIKOV, S. S. and MAYDONOVSKIY, A. S.

[Abstract] Using as an example two transistorized microwave self-oscillators connected by sections of long lines through a power ring-type adder, the effect of the parameters of a complete communication circuit on a regime of synchronous oscillations is experimentally investigated. The investigations conducted show that regimes of synchronous operation of coupled self-oscillators are determined by both the external and the output circuits of the self-oscillators. Cophased or antiphased oscillations are excited in the system as a function of the electrical length of sections of lines  $\theta$ . A region of values  $\theta$  exists, corresponding to one or another regime. With an increase of coupling between self-oscillators operating at a common load, entering into a communication circuit, the area of a regime with an additions power (synphase--for parallel, and antiphase--for successive loads) is considerably reduced in area. Figures 2; references: 7 Russian.  
[68-6415]

UDC 621.373.029.6:621.382.3

### APPLICATION OF THE METHOD OF HARMONIC BALANCE TO PROBLEMS OF ANALYSIS AND SYNTHESIS OF RADIO-FREQUENCY OSCILLATORS BASED ON BIPOLAR TRANSISTORS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2136-2145  
manuscript received 25 Apr 79

PETROV, B. Ye.

[Abstract] Although the method of harmonic balance in the conventional monoharmonic approximation avoids the difficulties associated with I. A. Popov's method of analyzing transistorized oscillators on the basis of periodically repeated transient processes, it brings its own disadvantages when used for studying nonlinear modes of oscillator operation, specifically the difficulty of locating a coordinate that



satisfies contradictory requirements: 1) Time dependence close to harmonic; and 2) Zero-lag nonlinear relations between the chosen coordinate and the other quantities that characterize the state of the transistor. In the present paper, the author gets around this difficulty by using a method of harmonic balance that is based on the hypothesis of autofiltration [B. Ye. Petrov, "Radiotekhnika," Vol 28, No 3, 1973, p 1]. The analysis uses a nonlinear model of the bipolar transistor set up in such a way that the instantaneous state of the transistor is characterized by a single quantity: the controlling voltage across the emitter p-n junction or the controlling charge. Conditions are determined under which the controlling charge is the quantity that gives the near-harmonic coordinate. On the basis of these conditions, averaged parameters are found for a microwave transistor for constant terms and first harmonics. Estimates are made of the influence that higher harmonics have on the forms of periodic processes. Practical recommendations are formulated for design of the input and output circuits of transistorized oscillators. Figures 5; references 18: 17 Russian, 1 Western. [80-6610]

UDC 621.382.2.029.64

#### FEASIBILITY STUDY ON EXTENDING THE FREQUENCY BAND OF GUNN-DIODE OSCILLATORS BY USING BIHARMONIC OPERATION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2127-2135  
manuscript received 3 Jan 78

KOSOV, A. S., POPOV, V. I. and STRUKOV, I. A.

[Abstract] An important problem of microwave electronics is increasing the frequency range of solid-state oscillators. In this connection, the optimum device for pumping low-noise reception circuits in the millimeter band is the Gunn-diode oscillator. The authors consider the possibility of raising the frequency limit of Gunn diodes by using a two-frequency mode of oscillation in which the device produces signals on the second harmonic in addition to the fundamental frequency. The principal goal of the research was to determine the capability for second-harmonic oscillation in the frequency band where the device has positive impedance. The basis of the analysis was a model that accounts for the finiteness of the time of the interval transition. The frequency dependence of power generated on the second harmonic was determined up to 220 GHz. Problems of the stability of two-frequency systems are examined, and a system of equivalent parameters is found, as well as the way that these parameters depend on operating conditions and emission frequency. It is shown that biharmonic operation improves oscillator efficiency on the fundamental frequency, and also holds promise for systems requiring synchronous emission of signals with frequency differing by a factor of two. The Gunn-diode biharmonic oscillator is compared with cascade connection of an oscillator on the fundamental frequency and a frequency doubler. Experimental results are given for oscillators on 20, 60 and 100 GHz. The results show that the power on the second harmonic is sufficient for pumping a parametric amplifier or as a heterodyne for a mixer. Figures 5; references 22: 6 Russian, 16 Western. [80-6610]

PHOTOELECTRIC PHENOMENA AND DEVICES,  
ELECTROLUMINESCENCE, ION DEVICES

UDC 621.311.6:621.383.5

A HIGH-VOLTAGE STABILIZED POWER SUPPLY FOR A PHOTOMULTIPLIER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 152-154  
manuscript received 9 Jan 79

KUREYCHIK, K. P. and ZAIKIN, S. A., Belorussian State University, Minsk

[Abstract] The article describes a high-voltage power supply for a two-beam atomic absorption spectrophotometer using two photomultipliers. The 2000 V output is adjustable by stages every 10 V, the load current is up to 4 mA, and time instability for ten hours of continuous operation is 0.01%. Temperature instability is 0.001% over a range of 10-45°C, and peak-to-peak voltage fluctuation is 20 mV. Supply voltage is 24 V unipolar and +12 V bipolar. Power consumption is 18 VA. The power supply consists of a 15 kHz master oscillator, a full-wave up-converter, a step-up transformer, a high-voltage multiplier with filter, an adjustable voltage stabilizer and a DC microammeter for monitoring the output voltage. Negative feedback is used to eliminate the influence of the load on the output voltage. Figure 1; references 3: 2 Russian, 1 Western.  
[62-6610]

UDC 621.383.292

THRESHOLD CHARACTERISTICS OF PHOTOMULTIPLIERS IN THE NEAR-CATHODE RADIOHETERODYNING MODE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2216-2222  
manuscript received 30 May 79

MARTYUSHEV, Yu. Yu. and PETRUKHIN, G. D.

[Abstract] An examination is made of the major factors that determine the signal-to-noise ratio at the output of a photomultiplier used in the mode of frequency conversion of the envelope of an intensity-modulated optical signal by using alternating electrical or magnetic fields introduced into the cathode chamber. An engineering formula is derived for calculating this ratio with consideration of shot noises of the thermionic current of the photocathode, and also noises caused by the conversion process. The influence that the diode system of the photomultiplier has

on the signal-to-noise ratio is also considered. Results of experimental verification are given for FEU-117 and FEU-62 photomultipliers on wavelengths of 0.63 and 0.9  $\mu\text{m}$ , respectively, for the 100 Hz noise band. It is shown how operation can be optimized in order to maximize the signal-to-noise ratio, and the threshold sensitivity is calculated for actual photomultipliers operating in this "radioheterodyning" mode. Figures 3; references 9: 7 Russian, 2 Western (1 in translation).  
[80-6610]

UDC 621.311.001.57:658.3.012

## DISCRETE DYNAMIC MODEL--LOAD DISPATCHER TRAINER

Moscow ELEKTRICHESKIYE STANTSII in Russian No 8, 1980 pp 16-18

KAGALOVSKIY, M. A. and ORNOV, V. G., engineers, Energoset'proyekt [All-Union State Planning, Surveying and Scientific Research Institute of Power Systems and Electric Power Networks] Institute and USSR Unified Power System Central Dispatching Administration

[Abstract] A description is given of a discrete dynamic model of the USSR Unified Power System, designed by the Energoset'proyekt Institute and the Central Dispatching Administration for the purpose of training load dispatching personnel and for analyzing conditions when an imbalance originates in active power in individual regions and for dividing the Unified Power System into nonconcomitantly operating parts and the like. The model is run on a Videoton 1010B minicomputer, monitoring and control are accomplished by means of displays and the information is recorded on an alphanumeric printer for the purpose of analyzing the results. In this model the Unified Power System is represented by an eight-node radial system whose nodes correspond to united power systems and whose branches to equivalent connections between them. The model makes it possible to estimate and map the change over time of the frequency and overcurrents of active power between interconnections as a function of the change in the balance of active power in interconnections, taking into account statism with regard to the generating and load frequency. For each node of the model in tabular form 12 hourly values are preassigned with the following parameters: the effective generated power, the planned generated power, the planned load power, planned "disturbances" of the generating and load power, and statism coefficients for the frequency of the generating and load power. The following equation is used to determine, for moment of time  $t$ , the initial values of the generating and load power for each node:  $P_{jt} = p_{jt}^{pl} + \Delta p_{jt}^{pl} + \Delta p_{jt}^{upr}$ , where  $p_{jt}^{pl}$  and  $\Delta p_{jt}^{pl}$  are the interpolated planned values of the power and  $\Delta p_{jt}^{upr}$  is the portion of the controlling influence assigned by the operator from the display's keyboard, used up as of moment of time  $t$ . A determination is then made of the instantaneous value of the frequency in the Unified Power System, of the instantaneous values of generation and load in nodes, taking into account the change in frequency, and the instantaneous values of overcurrents of the power in branches. The model's software is written in the Assembler (Astrol) language, using macroinstructions of the "Protss" package of programs. The software combination consists of two subsystems, one for mode modeling and one for communicating with the model. For preparing the model for operation in the trainer mode, parameters for a specific designated mode are entered in tables of planned goals. Then changes in generation or load of

individual nodes, designated for specific hours of the day, are entered in tables of disturbances. The disturbances are selected to cause an intolerable change in frequency or division of the Unified Power System into nonconcomitantly operating parts. The load dispatcher being trained does not know beforehand the nature and time of planned disturbances. This individual's task is to ensure maintenance of the frequency and intersystem overcurrents within prescribed or tolerable limits by influencing generation or consumption in individual nodes. This is accomplished by means of a display with a keyboard. A second display can be used by the training director, who can change planning goals, can form unexpected controlling effects and can cut off connections between systems. The results recorded on the alphanumeric printer make it possible to rate the success of the load dispatcher's actions. The model described can be used not only as a trainer, but also for planning and analyzing the balance of active power of the Unified Power System within a 24-hour period. Figures 1.

[40-8831]

UDC 621.311.176.002.237

#### PLANT CONTROL BOARDS OF A NEW TYPE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 8, 1980 pp 18-20

SVISHCHEV, R. V. and TINKER, Ye. M., engineers, Teploelektroproyekt [All-Union State Institute of the Planning of Electrical Equipment for Heat Engineering Structures] Institute, Rostov Division

[Abstract] It has been demonstrated that removing the plant control board beyond the limits of the technological equipment, in the case of 800-MW pulverized coal power plants, is the most effective means of satisfying practically all strict requirements relating to working conditions for personnel and for equipment, to construction of the plant control board, and to the installation and debugging of automated control system hardware. A brief description is given of the design solutions used for the layout of the plant control board of a large thermal electric power plant, using the Berezovka GRES (State Regional Power Station) as an example. The advantages and disadvantages of this arrangement are listed. The plant control boards at the Berezovka GRES-1 are located in buildings especially erected for them, which adjoin the central building on the engine room side. Each building houses control boards for two plants. Placing the control boards for two large power plants in a single area is a new idea and has resulted in considerable savings. The plant control board buildings are made of standard ferroconcrete structures. Since these buildings can be erected quickly it is possible to get an early start on debugging the automatic control system equipment, which is a labor intensive and time consuming process and can delay the startup of a power plant. It is shown that the construction of a separate building for the plant control board in the case of the Berezovka GRES made it possible to reduce the length of the main building by one section per plant, resulting in a savings of 1.6 million rubles per plant in construction



costs. A diagram is given of the layout and design of the plant control board building. The operating panels, the mnemonic chart and consoles are installed on an arc with a radius of 12 meters, in order to improve the visibility of a rather extensive array of equipment. The control room is high and spacious with an esthetic interior for improvement of the working conditions of operating personnel. This operations center is connected by means of two corridors to the engine room and by means of stairways and an elevator to the other floors of the building. The information and computing complex (IVK) is located as close as possible to the operating equipment in order to shorten cable connections and eliminate the influence of induction on the operation of the complex. Cables for equipment meet and run along cable stages which are interconnected by means of cable shafts. Electrical equipment such as storage batteries and power supplies for the IVK is housed on the second floor of the building and the first floor is occupied by living areas for duty personnel. The areas for the IVK and operating personnel are air conditioned. The control room is lit with natural light. The distance of the plant control board building from large generating units makes it possible to eliminate the influence of vibrations caused by these units. The key disadvantage of this solution is a somewhat increased consumption of control cable, amounting to approximately 6.5 to seven percent, as compared with the traditional location of the plant control board between the boilers and turbines. Figures 1; references: 2 Russian. [40-8831]

UDC 621.315.2.027.850

#### 500-kV CABLE LINES

Moscow ELEKTRICHESKIYE STANTSII in Russian No 8, 1980 pp 51-56

MAKIYENKO, G. P., KUZNETSOV, A. L. and STOLBOV, Yu. V., engineers, Kamo Cable Plant

[Abstract] A detailed description is given of 500-kV cable lines used for the first time in the USSR at the Ust'-Il'msk and Toktogul GES's (Hydroelectric Power Stations). These are used for the purpose of transmitting electric power from step-up transformers installed several meters from the hydroelectric generators to an outdoor distribution system or a junction point at which they are connected to overhead electrotransmission lines. These lines are 950 to 1050 m long and they are placed at levels differing by 45 m along the route. These lines can transmit power as great as 630 MV·A. The cables are run in steel conduits which in turn are laid along two tunnels. The conduits are bent at two places with a resulting overall bending radius for the line equal to 48 m. Brand MVDT cable is used; this is a high-pressure oil-filled cable in a lead sheath which is removed before the cable is drawn into the conduit at the point of installation. The core has a cross section of 625 mm<sup>2</sup> with a diameter of 32.6 mm. The cable weighs 30,460 kg/km in its temporary lead sheath and the lead sheath weighs 14,350. The copper core is wrapped in strips of semiconducting black paper and a single two-color semiconducting strip 0.08 mm thick to serve as insulation. The paper insulation is impregnated with S-220 oil and the

thickness of the insulation was selected to provide a permissible working electric field strength of 15 kV/mm. Over the insulation a shield is wrapped which consists of a single strip of semiconducting paper 0.12 mm thick, additional strips of semiconducting paper, a single strip of metallized perforated semiconducting paper wound with the metal on the outside, and a single copper perforated strip, wound with a 2- to 3-mm overlap with a lining consisting of a strip of semiconducting paper. Two semicircular copper glide wires measuring 2.5 X 5.0 mm are wrapped around the shield to protect it and the insulation from damage when the cable is pulled into the conduit. This cable is delivered to the point of installation in lengths measuring 200 to 300 m. The steel conduits come in lengths of 9 to 12 m and their outside surface is coated with bituminous paint as the only means of corrosion proofing. The lengths of conduit are joined one by one by means of an insert ring and welding. A hydraulic pipe bender is used to bend them. The results are given of tests conducted to determine the air tightness of the conduits after assembly. The cable is run into the steel conduit at an assembly platform situated at the outdoor distribution system. A special tent is constructed to maintain a temperature of 18 to 25°C and a relative humidity of not greater than 50 percent when inserting the cable into the conduits. Lead stripping machines are used to remove the lead sheath. Winches are used in running the cable through the conduit. The ends of a cable after being inserted into a conduit are made airtight with special seals. The conduit with the cable is evacuated to a negative pressure of not greater than 2.0 mm Hg and is filled with nitrogen desiccated by using silica gel to a pressure of 0.3 to 0.5 kg/cm<sup>2</sup> and this pressure is maintained for the entire period that the line section being installed is mothballed; this period lasts no longer than 125 days. Core ends are pressed together and soldered. Copper conduits are employed for branching. A detailed description is given of terminals, branching and coupling connectors and transformer lead-ins. After the last lead-in is connected to the transformer, the cable line is evacuated and filled with degassed S-220 oil. Approximately 40 tons of this oil are required for filling a line 1 km long. Figures 5; references: 2 Russian.

[40-8831]

UDC 621.311.4.027.840/.89-784.62

#### EXTENDED SCREENS AT SUBSTATIONS WITH VOLTAGE OF 400 kV AND ABOVE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 80 pp 38-42

SMEKALOVA, N. S. and STOLYAROV, M. D., engineers, Soyuztekhnenergo

[Abstract] The electrical field at substations with a voltage of 400 kV and above can exert an adverse effect on personnel, and accordingly various screening devices must be used at these substations, among them extended screens (overhangs). The present paper describes a simplified method developed at Soyuztekhnenergo for determining the coefficient of screening which can be used during engineering calculations of overhangs. Recommendations are given with respect to a selection of the

parameters of the overhangs which will give the necessary effectiveness of the working zone in both summer and winter. A positive test has been made of the operation of overhangs at a number of substations with voltages of 500 and 750 kV. The overall appearance of a cable overhang is shown. Figures 3; tables 2; references: 4 Russian.  
[73-6415]

UDC 621.311:631.63

#### PRINCIPLES OF CONTROL OF ELECTRICAL POWER SYSTEMS

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 3(105), Jul-Sep 80 pp 16-19

LEPORSKIY, V. D., candidate of technical sciences, Kiev Polytechnical Institute

[Abstract] Problems are considered concerned with the creation of territorily and functionally distributed systems of data processing, and the adoption of solutions in electrical power systems, economically more effective than centralized systems. A block diagram is presented and explained of a distributed system for adoption of solutions. The system accomplishes the processing of information and control. The following items are discussed: 1) Principle of immediate (direct) coordination of the local and global functions of the objective; 2) Principle of the least deviation; 3) Principle of equivalency of the external (real) world; 4) Principle of closed condition of system of coordinatization; 5) Principle of simplicity of control algorithms; and 6) Principle of complexity. Figures 1; references 3: 2 Russian, 1 Western.  
[66-6415]

## MICROCOMPUTER FOR AUTOMATION OF OPERATIONAL-DISPATCHER CONTROL IN POWER ENGINEERING

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 80 pp 33-36

ORNOV, V. G., engineer, SEMENOV, V. A., candidate of technical sciences, CHERNYA, G. A., MITYUSHKIN, K. G., ARONOV, G. M. and KAGALOVSKIY, M. A., engineers. TsDU [Central Dispatching of the Integrated Power System of Socialist Countries]; SSSR-VNIIE-Energoset'proyekt [USSR--All-Union Scientific-Research Institute of Electrical Power--All-Union Order of the October Revolution State Planning, Surveying and Scientific-Research Institute of Power Systems and Electric Power Networks]

[Abstract] The most promising trends in the use of microprocessors and microcomputers for automation of operational-dispatcher control in power engineering are considered. The first results in the creation of information networks and systems, means of representation and automatic control devices are presented. The following block diagrams are discussed: 1) Low-speed network of interlevel intermachine interchange of operational information; 2) Structure of microprocessor multiplexers on a base of a type RPT microcomputer manufactured by the Hungarian People's Republic; 3) Structure of two-machine complex of microprocessor multiplexers; and 4) Structure of teleinformation system. A number of organizations involved in the work are listed. Figures 4; tables 1; references: 2 Russian.

## TEST OF USE OF MN-4 OIL IN 110-220 kV CABLE LINES

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 80 pp 70-71

SHCHEGLOV, A. P., engineer, Leningrad Cable Network of Leningrad Rayon Power Administration

[Abstract] Beginning in 1972 low-pressure cable filled with MN-4 oil produced by the Yaroslav Petroleum Processing Plant arrived at the Leningrad Cable Network of the Leningrad Rayon Power Administration. Lines formed with these cables have successfully been exploited up to the present. The parameters of the oil in them have not changed with respect to the values present when the lines were placed in operation. However, from here on filling in of the 110--220 kV input lines of low and high pressure will be accomplished with MN-4 oil produced by the Gorkiy Petroleum Processing Plant. Because petroleum from various fields and the properties of the oil produced from it are unlike, samples were taken from some elements of the lines filled in with MN-4 oil. The results of the tests are described, with the oil from the Gorkiy Plant having high values of  $\text{tg}\delta$  and instability. Figures 1; tables 2.

[73-6415]

## TESTS OF CIRCUIT OF FOUR-BEAM REACTOR FOR 750 kV POWER TRANSMISSION

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 3(105), Jul-Sep 80 pp 37-40

BELYAKOV, N. N., RASHKES, V. S., SAVCHENKO, Ye. V., candidates of technical sciences; TALOVER'YA, V. L. and KOYETSIAN, K. V., engineers, All-Union Scientific-Research Institute of Electric Power (VNITE), Ukrainian Ministry of Power, and Central Scientific-Research Electrical Engineering Laboratory (TsNIEL) of Donbas Power

[Abstract] The first stage of the utilization of the scheme of a four-beam reactor in Soviet 150 kV electrical transmission consisted of tests of an experimental installation on the 417 km 750 kV Dnepr-Vinnitsa line. These tests were conducted in 1979 by workers of the All-Union Scientific-Research Institute of Electric Power (VNIIE) and the Central Scientific-Research Electrical Engineering Laboratory (TsNIEL) of Donbas Power. A short description of the experimental installation for the four-beam reactor and the results of the tests are given. The experimental installation of the four-beam reactor was mounted in the neutrals of two groups of shunting reactors. In some tests an additional group of shunting reactors from a neighboring 750 kV line was also connected to the line. The test circuit is shown. Stabilized lightning gaps were developed and produced for the tests at the Scientific-Research Institute of Direct Current (NIPT). Recommendations are made with respect to the introduction of the installations of a four-beam reactor. Figures 2; references 3: 2 Russian, 1 Western.  
[66-6415]

## TO THE PROBLEM OF MONITORING THE RELIABILITY OF POWER SUPPLY SYSTEMS OF INDUSTRIAL ENTERPRISES

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 3(105), Jul-Sep 80 pp 15-16

ORLOV, N. N. and SESTERENKO, V. Ye., candidates of technical sciences, Kiev Technological Institute of the Food Industry

[Abstract] An instrument based on a type RESP-1 clock mechanism is proposed which eliminates the shortcomings of the self-recording instruments and devices based on synchronous motors used at present for recording the quantity and times of interruption in electrical networks. The recorder of interruptions is designed for fixing the total time of interruptions of electrical supply, the overall number of disconnections, and the amount of interruptions above a specified fixed period. A block diagram and the principal circuits of the recorder are presented and its method of operation is described. The recorder makes it possible to improve the organization of work with respect to operation and maintenance of electrical networks, which also



makes it possible to reduce energy losses and to decrease the magnitude of the damage from underdistribution of electrical power. The instrument has been introduced into the Levoberezhnyy enterprise of electrical networks of the economic planning division of Kiev Power. The RESP-1 recorder is exhibited at the "Electrification of the USSR" pavilion of the Exhibition of Achievements of the National Economy of the USSR. Figures 2.

[66-6415]

UDC 658.5.011

PRINCIPAL DIRECTIONS OF USE OF COMPUTING TECHNIQUES FOR IMPROVEMENT OF TECHNICAL AND ECONOMIC INDICATORS OF THE BURSHTYN STATE REGIONAL ELECTRIC POWER STATION

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 3(105), Jul-Sep 80 pp 34-36

KOROTOV, Ye. I. and ZDANOVSKIY, V. G., engineers, Burshtyn Regional Electrical Power Station

[Abstract] The complex of hardware of the automated control system (ASU) of the Burshtyn State Regional Electric Power Station consists of a computing center based on a "Denpr-21" computer which accomplishes automatic collection, processing and distribution of primary and calculated information to a number of individuals. Each 30 seconds the "Dnepr-21" collects information with respect to all power units and each 15 minutes calculates technical and economic indicators. Hourly averaged and calculated information as well as information per period from the beginning of the shift are presented by means of an accumulation of 15-minute information. Two programs are used at present in practice: calculation of technical and economic indicators (TEI) and distribution of the load between power units. The following problems are solved on the basis of a calculation of the TEI: optimization of the performance of the power units; attestation of the quality of work of duty personnel and organization of socialist competition between duty-shifts of monitoring and training cycles, and tests of heat engineering equipment. It is shown that introduction of a computer made it possible substantially to increase the standard of operation of power units and the level of organization of all economic work at the GRES, and at a qualitatively higher level to organize socialist competition and attestation of the work of personnel at the enterprise.

[66-6415]

UDC 678.026.3:621.319.7

ELECTROSTATIC APPLICATION OF POLYMER POWDER MATERIALS BY THE METHOD OF 'BRENNING'

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 9, 1980 pp 35-36

INDZHOV, K., engineer, Bulgaria

[Abstract] The method of "brenning" is a modification of the classical electrostatic technique for applying polymer powders to surfaces. The distinguishing feature of the new method is that purely electrostatic forces are used for transfer of material, thus eliminating the need for regeneration and collection of unused material that is scattered when air is used as a transfer agent. The polymer material is located on the bottom of the enclosed working space. Between coiled electrodes in the material and another electrode on the inside of the working space an "electrostatic vibrator" effect is set up with voltage that can be controlled from 0 to 12 kV. As a result of continuous alternation of charging and polarization of the particles and the floor of the chamber, the powder is set into intense vortical movement. An electrostatic field is set up throughout the working space between the high-potential electrodes and the grounded workpiece to be coated. The powder particles travel along the lines of force of this field, and settle on the workpiece at each point where such a line terminates. The parameters of the equipment can be varied to get coatings from 40 to 100  $\mu\text{m}$  thick. Uncharged powder remains on the bottom of the chamber until the electrostatic field acts on the particles. Test results show that the method can be used for electrostatic coating of openwork parts. However, more work is needed to adapt the technique to parts of three-dimensional type with relatively deep cavities. Figure 1.

[82-6610]

CHARGING POLYMER POWDER COMPOSITES BY THE TRIBOELECTRIC EFFECT

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 9, 1980 pp 36-37

SLEMZIN, B. V., VINOGRADOVA, E. S., ZAMULIN, V. G. and DILIGENSKIY, Yu. N., engineers

[Abstract] An analysis is made of the process of electrostatic application of powdered polymer coatings to surfaces by using the triboelectric effect. Regression equations are derived that describe the influence that the composition of polymer powder pigments, the chemical nature and length of the transfer components of pulverizers and air pressure have on the effectiveness of electrification of powder composites. The results of the analysis have been used to design facilities for applying polymer coatings using the triboelectric effect. These facilities have been industrially tested and introduced at three plants. The resultant savings is more than 400,000 rubles per year. Figures 3; tables 1.

[82-6610]

## A PICOSECOND PULSE SHAPER BASED ON A GUNN DIODE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 109-110 manuscript received 12 Feb 79

AYZENSHTAT, G. I. and DONTSOV, V. N.

[Abstract] Circuits using Gunn-diode oscillators can be designed to produce ultra-short pulses. However, off-the-shelf Gunn diodes have a low value of the parameter  $n\ell$ , where  $n$  is the concentration of free electrons in the active layer, and  $\ell$  is the length of the active layer. Because of this, they either will not work at all in the bistable mode, or they generate a weak output current when switched. Gunn-diode oscillators also have a comparatively high parasitic capacitance. This paper describes a picosecond pulse shaper based on a planar Gunn diode with  $n\ell = 5 \cdot 10^{13} \text{ cm}^{-2}$ . The diodes were made from epitaxial GaAs with active layer 10  $\mu\text{m}$  thick and electron concentration in the layer  $n = 10^{16} \text{ cm}^{-3}$ . Distance between anode and cathode was  $\ell = 50 \mu\text{m}$ , and the width of the diode was 40  $\mu\text{m}$ . In operation as a bistable device the diode generated a pulse with duration of 500 ps, rise time and fall time of about 50 ps and amplitude of 80 mA through a load of 50  $\Omega$ . The pulses were shaped in a differentiating resistive-inductive circuit. To make a picosecond pulse shaper, such a diode was placed in a break in the central conductor of a coaxial waveguide with wave impedance of 50  $\Omega$ . The cathode was grounded by two silver wires 30  $\mu\text{m}$  in diameter and 3 mm long acting as the inductance. The 19 V supply pulse was produced by a nanosecond pulse generator, and a 2 V trigger pulse with duration of 500 ps was produced by a diode with charge accumulation. The resultant pulse had a duration of 80 ps on the 10% level at an amplitude of 2 V. It is noted that it should be possible in principle to use such circuits for generating pulses with a duration of 20-30 ps. Figure 1; references 2: 1 Russian, 1 Western. [62-6610]

## A COHERENT PULSE SOURCE WITH EMISSION WAVELENGTH OF 118 nm

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 200-202  
manuscript received 2 Feb 79

BERKOV, V. I., KOROBKIN, V. V., KOROBKIN, Yu. V., MARKIN, A. S., PROKHINDEYEV, A. V. and STUDENOV, V. B., Physics Institute, USSR Academy of Sciences, Moscow

[Abstract] Coherent sources are promising for analyzing dense and superdense plasma because holographic methods can be used for diagnosis. This paper proposes a pulsed coherent source of radiation on a wavelength of 118 nm with peak power of about 100 kW. The master laser uses a three-mirror traveling-wave ring cavity with a passive gate in one arm, and a selector that keeps reproducibility at almost 100% for complete synchronization as the spectral width is narrowed. The source uses cascade up-conversion of emission from a self-mode locked neodymium laser ( $\lambda = 1060$  nm) to the second, third and ninth harmonics in media with square-law and cubic nonlinearity. The output pulse has a duration of 150-200 ps and energy of 0.4-0.5 J. With comparatively simple changes, the device should be able to produce two or more pulses with a fixed delay. The authors thank P. P. Pashinin for useful discussion stimulating the work. Figures 3; references 5: 3 Russian, 2 Western.  
[62-6610]

## A SHAPER THAT PRODUCES PULSES OF STABLE DURATION FROM STATISTICALLY DISTRIBUTED SIGNALS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 111-113  
manuscript received 6 Oct 78

TSAPKO, G. P., POKROVSKIY, A. V. and TOUSHKANOV, Yu. K., All-Union Scientific Research Institute of Electronic Internal Inspection Affiliated with Tomsk Polytechnical Institute

[Abstract] A counting-rate method of indication can often improve the accuracy of radioisotope devices for inspecting materials. In a device where the radiation detector operates in the counting-rate mode and measurement results are represented as a continuous analog signal, it is advisable to measure the average counting rate by integrating pulses that are normalized with respect to amplitude and duration. Compensated switches can reduce amplitude instability to about 0.01% or less. However, conventional techniques are not applicable to shaping pulses with duration instability of the order of 0.05% or less. This paper describes a shaper in which the duration of statistically distributed output signals is a multiple of the period of a quartz-controlled reference oscillator signal. Counting losses are reduced by



frequency leveling of the flow of input pulses as they are shaped. The circuit is based on ICs. Pulse duration instability is less than  $10^{-4}$ . The frequency of input signals is less than 1 MHz, and the duration of the shaped time intervals can be set discretely in a range of 0.5-64  $\mu$ s. The use of a three-place register reduces counting losses by about 80-90% or more. The working temperature range is from -10 to +60°C. Figures 2; references: 5 Russian. [62-6610]

## QUANTUM ELECTRONICS

UDC 621.316.933.5+621.384.6

### LASER IGNITION OF WATER-FILLED SPARK GAP OF THE DOUBLE SHAPING LINE OF AN ELECTRON ACCELERATOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 93-95 manuscript received 28 Jun 78

DIMIDOV, B. A., IVKIN, M. V. and PETROV, V. A.

[Abstract] An investigation is made of the characteristics of a water-filled commutator with initiation by laser spark on the Kal'mar accelerator with potential of 600 kV across the double shaping line. A neodymium glass laser was used with energy of 7.5 J and pulse duration of 25 ns. Experimental results show that the delay of spark gap operation relative to the laser pulse front is 60 ns with a spread of  $\pm 8$  ns. Laser commutation reduces the rise time of the shaped pulse by 10-15% and cuts energy losses in the commutator by a factor of 1.5. Laser ignition should enable development of a multichannel water-filled commutator in relativistic electron accelerators with slow charge of the double shaping line. The authors thank N. A. Klepikov for measuring the laser pulse energy. Figures 4; references 6: 5 Russian, 1 Western.

[62-6610]

UDC 621.373.826

### NUMERICAL MODELLING OF THE PROPAGATION OF $\lambda = 10.6$ MICRON RADIATION THROUGH WATER-DRIP AEROSOL UNDER THE CONDITIONS OF THERMAL SELF-INFLUENCE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 9, Sep 80 pp 1793-1800 manuscript received 21 Feb 79

ARMAND, S. A. and POPOV, A. P.

[Abstract] The results are presented of numerical calculations on a computer of the electromagnetic field of a laser beam  $\lambda = 10.6$  microns which is propagated through an aqueous aerosol. In the initial conditions, the effect of thermal self-influence is taken into account. The method of finite elements is used for calculations. This method makes it possible to obtain a system of network equations used directly

for computer calculations. The method of finite differences in the form of an implicit scheme of Krank-Nicholson was used for the case of a clear atmosphere with low absorption. Approximate calculations of the field of laser emission in an aerosol medium under conditions of thermal self-influence were made on the basis of the same model. The basic faults of the approximate calculations are outlined. The numerical results presented are qualitatively analyzed in accordance with the parameters which characterize the physical nature of the phenomena. The optimum conditions are shown which are imposed on the intensity and radius of the beam when it is necessary to assure a required effectiveness of clarification. Figures 4; tables 1; references 5: 3 Russian, 2 Western (in translation).  
[68-6415]

UDC 621.373.826:621.382

#### USE OF A SCANNING SEMICONDUCTOR LASER WITH ELECTRONIC PUMPING IN OPTICAL MICROSCOPY

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2254-2258  
manuscript received 15 May 75

SAPARIN, G. V., NASIBOV, A. S., OBYDEN, S. K., REZNIKOV, P. V. and KOMOLOVA, L. F.

[Abstract] One of the recent advances in the use of lasers is applications in scanning optical microscopy. This paper describes experiments and gives results on the use of semiconductor lasers with longitudinal electronic pumping used for illuminating the specimen on a scanning electron microscope operating as an optical microscope. The experiments were done with a CRT with a semiconductor laser screen that has been used in color projection television. The laser beam produced by electron-beam scanning of the CRT screen was concentrated in the object plane by a short-focus lens. A variety of forms of interaction between the luminous flux and matter determines the local difference in the video signal and image contrast. Reflection and transmission signals can be used, and the light can be used in order to produce a response in various photomultipliers and photoresistors from which the video signal is sent to a monitor with scanning synchronized with that of the electron beam that stimulates laser emission. The results show that such a system is capable of resolution on the order of micrometers. Figures 4; references 14: 6 Russian, 8 Western.  
[80-6610]

ESTIMATING THE STATE OF A SYSTEM WITH A NONLINEAR MOTOR BY THE KALMAN METHOD

Leningrad IZV. VUZ: PRIBOROSTROYENIYE in Russian Vol 23, No 9, Sep 80 pp 58-62  
manuscript received 11 Jun 79

LEPORSKIY, A. A., Leningrad

[Abstract] Gyro stabilization is considered for a power platform with a nonlinear driving motor in each channel, whose characteristics are not completely known. The state variables of one channel, namely its angular coordinates and velocities, are estimated with the aid of Karman filters. Here this method is analyzed in two important practical cases. In the first case the angular velocities of stabilization and precession are to be estimated, with the precession angle being measured. In the second case the angular velocity of precession is to be estimated, with the precession angle and the angular velocity of stabilization being measured. In each case the possibility of estimating is established on the basis of the observability matrix. The results indicate that an asymptotic estimate can be made with the aid of a nonlinear filter whose linear approximation is observable and with information about the motor control voltage. With another tachometer available for measuring the angular velocity of the platform, an asymptotic estimate can be made with the aid of a linear filter which is invariant with respect to the control action. The author thanks S. S. Rivkin, dr. of technical sciences, for valuable council and comments on the work. References: 3 Russian.  
[71-2415]

## AN OPTIMIZATION CRITERION FOR TRACKING SYSTEMS

Leningrad IZV. VUZ: PRIBOROSTROYENIYE in Russian Vol 23, No 9, Sep 80 pp 35-39  
manuscript received 6 Jun 79

VAGAPOV, V. B.

[Abstract] The three conventional optimization criteria for tracking systems where the error can be described as a stationary random process are: minimum mean-square error, minimum probability of error excursion beyond a prescribed limit, and minimum probability of cutoff. They are neither equivalent nor universal, each referring to a different performance requirement and involving a different method of system evaluation. A much more versatile criterion would be the minimum value of the error normalized with respect to the limit  $L$  and raised to the  $n$ -th power:  $M(\epsilon_L^n) = \min$ .

This criterion becomes equivalent to the minimum mean-square error when  $n = 2$ , but the weight of errors within the limit rapidly decreases and the weight of errors beyond the limit rapidly increases with a larger  $n$ . It then approaches the minimum probability of error excursion beyond the limit, but it also retains a constraint on the magnitude of that excursion. A problem is the choice of exponent  $n$ . For high accuracy  $n = 2$  is recommended unequivocally. For minimum probability of error excursion, however, the choice remains intuitive and empirical within the  $n = 16-20$  range. A curve depicting the dependence of the system transfer ratio which will ensure the minimum  $\epsilon_L^n$  on the exponent  $n$  as  $n \rightarrow \infty$  can be helpful here. A similar criterion can be established for the case where the error is a nonstationary random process. Cutoff can in any event be avoided by means of control optimization with a properly chosen penalty function. The paper was recommended by the Kiev Higher Military Aviation Engineering School. Figures 5; references 3: 2 Russian, 1 Western (in translation).

[71-2415]

## ANALYSIS OF A DOPPLER RADAR SYSTEM WITH CONSIDERATION OF FLUCTUATIONS OF THE TRANSMITTER SIGNAL

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 25, No 10, Oct 80 pp 2243-2245  
manuscript received 3 May 79

KRAYNENKOV, V. L., SILAYEV, A. M. and YAKIMOV, A. V.

[Abstract] An analysis is made of the operation of a radar system made up of an amplitude detector, a low-frequency filter and a Doppler filter connected in series. The input to the receiver includes the transmitter signal and the signal reflected from some moving object. The amplitude detector and low-frequency filter isolate



the envelope of the useful signal. The output from the low-frequency filter includes the heterodyne frequency resulting from mixing of the transmitter reference signal with the signal reflected from the target, and also correlated interference. The Doppler filter is added in order to isolate the signal from the interference and to determine the Doppler frequency shift, assuming that we know the statistics of the random processes that represent small relative fluctuations of phase and amplitude with time. An analysis is made of the simplest case of determining the Doppler frequency shift in the presence of such fluctuations of the transmitter signal. An estimate is given of the maximum permissible amplitude fluctuations of the transmitter signal for a given maximum permissible error. The authors thank A. N. Malakhov for discussing the work. Figures 3; references: 3 Russian. [80-6610]

UDC 629.13.014.69

#### ERROR AND SENSITIVITY ANALYSIS OF AN OPTIMAL LINEAR FILTER IN THE LONGITUDE CHANNEL OF A COMPLEX NAVIGATION SYSTEM

Leningrad IZV. VUZ: PRIBOROSTROYENIYE in Russian Vol 23, No 9, Sep 80 pp 53-58  
manuscript received 9 Oct 79

KARAKASHEV, V. A., ROMANENKO, S. G., FILIPPOV, A. S. and ANUCHIN, O. N.

[Abstract] An autonomous inertial navigation system is considered, where the use of optimal linear filters will improve the accuracy. The error and the sensitivity of the filtration algorithm are analyzed, for the purpose of estimating the accuracy of the system under real conditions different than those for which the system has been designed. This analysis is not exact, because of the high complexity and dimensionality of the system. It is reduced, as an approximation, to an analysis of the error in determining the longitude of an object from gyroscope readings, with the gyroscope drift described statistically as a first-order Markov process. Analytical expressions are derived for the steady-state values of elements of the real covariant error matrix and of elements in the sensitivity matrix. The latter elements characterize the sensitivity "in the large" of the optimal linear filtration algorithm to the inaccuracy of the system model caused by noise and thus represents the dispersion of estimation errors. Their limits as the correlation interval approaches zero characterize the sensitivity "in the small." The paper was recommended by the Department (Kafedra) of Shipboard Control Devices, Leningrad Institute of Precision Mechanics and Optics. Figures 2; references 3: 2 Russian, 1 Western. [71-2415]

UDC 548.25:537.533.8

A DEVICE FOR CONTROLLED GROWTH OF LAYERS OF LEAD CHALCOGENIDES AND SOLID SOLUTIONS  
BASED ON THEM

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 80 pp 196-198 manu-  
script received 10 Apr 78

SMORODINA, T. A. and TSURANOV, A. P., Physicotechnical Institute, USSR Academy of  
Sciences, Leningrad

[Abstract] Present-day requirements for the structure and chemical properties of semiconductor thin films make it necessary to monitor the state of the material in detail throughout the growth process. In growing epitaxial layers of lead chalcogenides and solid solutions based on them, condensation from the vapor phase gives the best results. However, combining the processes of growth and heat treatment with techniques that enable analysis of the chemical composition and structure of the crystal presents certain difficulties caused by high volatility that carries material into the analyzer chamber. In this paper, a device is described in which the growth chamber and Auger spectrometer are separated by mechanical gates and heat barriers that prevent migration of material into the analyzer space. The narrow-gap method of film growing is used to produce epitaxial layers of p-type with any degree of deviation from stoichiometric composition within the region of homogeneity of the material. The proposed device enables control of the technological process of growing epitaxial films of complex chemical composition as well as multilayer heteroepitaxial structures with a high degree of precision. Layers can be removed if their parameters do not meet specifications. A layer no more than ten atoms thick can be analyzed and corrected. Figures 3; references 7: 5 Russian, 2 Western.

[62-6610]

## ELECTROMAGNETIC SYSTEM FOR CONTROLLING THYRISTORS

Moscow ELEKTROTEKHNIKA in Russian No 8, 1980 pp 45-47 manuscript received 2 Aug 79

RYVKIN, A. M., doctor of technical sciences, SIROTA, S. M. [deceased], candidate of technical sciences and IVANNIKOVA, T. I., engineer

[Abstract] A method of controlling thyristors is discussed whereby spike pulses with a duration of a few microseconds are supplied to the thyristors. This method makes it possible to maintain the thyristors in the conducting state for a longer period of time on account of the electromagnetic energy stored during the rise time of the anode current in a transformer connected to the thyristor circuit. This makes it possible for a repeated broader control pulse to be formed automatically in a thyristor stage. A circuit diagram is shown for a thyristor with electronic control. The secondary winding of the transformer is connected via a diode to the control junction of the thyristor, which is triggered by means of a short pulse. The diode is included so that with a rise in current in the primary winding of the transformer the circuit of the secondary winding is cut off, and with a drop in the anode current the diode is opened and current flows in the loop formed by the secondary winding of the transformer and the control junction. Because of this function of the diode, until the thyristor's current rises the transformer behaves as an anode reactor since current does not flow through its secondary winding. At this stage the functions of the transformer reduce to decreasing the rate of growth of the current surge caused by discharging of the capacitance of the scaling and damping circuits of the thyristor and of that portion of the converter equipment which leads to the single thyristor stage. The thyristor's current magnetizes the transformer's core and stores electromagnetic energy in it. With a drop in the value of the thyristor's current the sign of the secondary winding's e.m.f. changes and the diode begins to conduct current; the secondary winding is loaded and the energy stored by the transformer is consumed in its circuit, which contains the thyristor's control electrode. As of the instant when the anode current reaches a maximum, a kind of self-sustaining effect is achieved: A control current flows through the thyristor's control junction and the energy stored by the thyristor's own current in the anode inductance is spent. The duration of the control current is considerably longer than the drop in anode current and is dependent on the amount of stored energy and the circuit's time constant, i.e., the ratio of the transformer's inductance on the side of the secondary winding to the resistance of the thyristor's control circuit, as well as on losses in the transformer's core. A disadvantage of this circuit is that a false control pulse can be triggered when the anode current drops rather quickly, such as in emergency situations. A control pulse with a duration of 1000 microseconds and longer can be achieved by using a transformer with an ShL25X32 core. Figures 4; references: 2 Russian.

[36-8831]

## RADIATION OF A CHARGE IN TRANSITION FROM AN ISOTROPIC MEDIUM TO A UNIAXIAL CRYSTAL

Gor'kiy IZV. VUZ: RADIOFIZIKA in Russian Vol 23, No 8, 1980 pp 982-987 manuscript received 28 Jun 79, after completion 1 Feb 80

DAVYDOV, V. A., Moscow State University

[Abstract] Interest has been created in studying sources in nonstationary media. A study is presented here of a uniformly moving charge in transition from an isotropic medium to a uniaxial crystal for the case of a random relative orientation of the optical axis and direction of motion of the charge. Radiation fields and the radiant energy of ordinary and extraordinary waves are computed for the case of an instantaneous change from an isotropic medium to a uniaxial crystal. Conditions for the sudden change dictate that electrical induction and its derivative in terms of time must be continuous at the moment of the sudden change. These conditions are expressed by a system of two vector equations containing six scalar. In an instantaneous change from an isotropic medium to a uniaxial crystal, two ordinary and two extraordinary waves are radiated for each value of the wave vector. The question is discussed of the compatibility of the system of equations describing conditions in the sudden change before computing the radiation field. The conditions under which this system has a unique solution are discussed. Employing the fact that in a nonstationary medium only transverse waves can be radiated and that only the transverse portions of the fields of the moving charge can be responsible for their radiation, a unique solution is found for the system of equations describing conditions at the sudden change. An expression is given for the transverse portion of the Fourier component of the induction of a uniformly moving charge in an isotropic medium with a specific constant, i.e., for the medium before the sudden change. Then the electrical induction of a uniformly moving charge in a uniaxial crystal is found. An expression is then derived for the total transverse field after the sudden change. The magnetic field strength of radiated extraordinary waves is found for the purpose of computing the radiant energy. The important particular case of the movement of the charge perpendicularly to the optical axis of the crystal is discussed. The radiation of extraordinary waves becomes zero in directions along and perpendicular to the optical axis. The magnetic field strength and radiant energy are computed for radiated ordinary waves. When transition from an isotropic medium to a uniaxial crystal is accomplished by means of the electrooptical Kerr effect, ordinary waves are not radiated. The author thanks B. M. Bolotovskiy for helpful comments and interest in the work. References: 7 Russian.  
[37-8831]

# INVESTIGATION OF PHOTOACTIVE SURFACE ELECTRONIC STATES OF GALLIUM ARSENIDE BY THE INFRARED SPECTROSCOPY METHOD

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian No 8, Aug 80 pp 1555-1563  
manuscript received 10 Jul 79, after final edition, 3 Jan 80

DMITRUK, N. L., LITOVCHENKO, V. G. and MAYEVA, O. I., Ukrainian SSR Academy of Sciences Institute of Semiconductors, Kiev

[Abstract] A study is made of the surface IR photoconductivity of epitaxial films of n-GaAs at 77 °K. Conductivity was measured in smooth epitaxial films of n-GaAs with a fine Si impurity concentration of  $N_d = 10^{15} \text{ cm}^{-3}$  and a thickness of 5 to 15  $\mu$  on a semi-insulating substrate; the quasi-surface conductivity was of the same order of magnitude as the total conductivity of the films. The surface was treated by the following methods: etching in a sulfuric acid etchant, passivation by means of a dielectric film of  $\text{Al}_2\text{O}_3$ , 5-10 Å thick, using the electron beam method, low-energy bombardment with  $\text{Ar}^+$  ions with  $E \sim 1 \text{ keV}$ , and doping the surface with  $\text{Au}^{3+}$  ions from an aqueous solution. An IKS-12 spectrometer was used to measure spectral dependences of the surface IR photoconductivity at 77 °K. An incandescent lamp was used as the light source. A GaAs filter in front of the light source eliminated the light scattered from the region of fundamental absorption of GaAs. The IR photoconductivity spectrum was recorded with unmodulated light and the intensity was measured by means of calibrated germanium and silicon photodiodes. After each measurement, with fixed  $h\nu$ , the sample was warmed to room temperature in order to restore the photoconductivity to the original level with good accuracy. Rapid measurements were made by exposing a sample of n-GaAs to white light through an Si filter. An analysis was made of the kinetic, steady-state, lux-ampere and spectral characteristics of "chilled" impurity surface photoconductivity. The results make it possible to determine the distribution of photoactive surface electronic states over the forbidden band and the dependence of the photoionization cross section on the energy of light quanta. This is possible because of the temperature-field retardation of electron exchange between the surface and body with constant unmodulated excitation. The data demonstrate the continuous distribution of surface electronic states over the forbidden band of gallium arsenide and an increase in the photoionization cross section with  $h\nu$  with continuous distribution of centers, as well as a reduction in the strength of the electron-phonon bond for surface centers in relation to body centers. The results are generalized for the surface impurity photoconductivity of wideband semiconductors, or semiconductors at low temperatures, with a surface depletion layer. Figures 7; references 17: 15 Russian, 2 Western.

[43-8831]



## ELECTROABSORPTION OF GALLIUM ARSENIDE WITH STRONG LUMINOUS FLUX

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian No 8, Aug 80 pp 1578-1581  
manuscript received 11 Nov 79, after final editing 11 Feb 80

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[Abstract] A description and the results are given of an experimental investigation of the modulation of strong luminous flux by means of the Franz-Keldysh effect with the employment of Schottky diodes based on gallium arsenide. The structure studied is a surface barrier contact produced by spraying a semitransparent film of aluminum onto an epitaxial film of gallium arsenide 30 microns thick with an electron concentration of approximately  $10^{14} \text{ cm}^{-3}$ . The experimental apparatus used a gallium arsenide semiconductor laser emitting 8 W of pulsed power as a light source. The operating wavelength of the laser could be varied over the range of 0.86 to 0.9 micron, which made it possible to measure the spectral dependence of the electroabsorption coefficient. The luminous flux was focused onto the specimen being studied by means of a lens, and a BZ-MA electrooptical converter made it possible to control the area of the light spot on the specimen. The maximum density of the luminous flux striking the specimen was estimated at about  $10^4 \text{ W/cm}^2$ . The luminous flux passing through the specimen and a diaphragm behind it was recorded by means of a multiplier phototube whose signal was fed to the input of a broadband oscillograph. The light was modulated by means of a pulsed voltage generator emitting pulses with an amplitude of up to 100 V and a duration of 1  $\mu\text{s}$ . Electroabsorption was measured by successively reading the amplitudes of the light pulse which had passed through without voltage in the sample,  $T(0)$ , and with the application of a voltage pulse,  $V - T(V)$ . The modulation factor was then calculated by the equation  $M = [T(0) - T(V)]/T(0)$ . A separate investigation was made of the behavior of the photocurrent in the region of the spectrum used with various voltages in the sample, in order to estimate the possible influence of a number of factors associated with the flow of photocurrent. The maximum photocurrent under conditions of electroabsorption approximately reached  $10^{-2} \text{ A}$ . This quantity of photocurrent when operating in the pulsed mode excludes such factors as heating of the specimen and the overcharging of deep centers. The major result of the study is the observation of the dependence of electroabsorption on the strength of the luminous flux. Spectral dependences are given for the modulation factor, measured with three values of the strength of the luminous flux, whereby one curve was measured in the region of low strengths at which electroabsorption does not depend on the intensity of the light. A dependence of the modulation factor on the intensity of the flux begins with a luminous flux density of about  $10^2 \text{ W/cm}^2$  and in the range of high density can be approximated by a logarithmic curve with a proportionality factor depending on the voltage applied. The reduction in the modulation factor with an increase in the strength of the luminous flux represents a reduction in absorption caused by the Franz-Keldysh effect. The absorption of light caused by the Franz-Keldysh effect with quantum energy less than the width of the forbidden band can be characterized by the exponential tail of the state density curve, which determines the change in

the absorption of light in an electric field. According to the experimental data, for light modulators based on gallium arsenide the limiting luminous flux density lies within the range of approximately  $10^2$  to  $10^3$  W/cm<sup>2</sup> in the case of Franz-Keldysh light modulators with strong luminous flux. The authors thank I. K. Potsepilov for technical assistance and A. V. Chaplik for interest in the work and helpful discussions. Figures 3; references 3: 2 Russian, 3 Western. [43-8831]

UDC 621.315.592

#### SURFACE HELICONS AT A SEMICONDUCTOR-METAL BOUNDARY

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[Abstract] A theoretical demonstration is given of the possibility of the existence of oblique surface waves of the helicon type at a semiconductor-metal boundary. In previous studies (1972 and 1979) the spectrum was produced of surface helicons in a magnetoactive semiconductor plasma bounded by a vacuum. A semiconductor plasma is assumed to occupy half-space  $y < 0$  and  $H_0$  is assumed to be directed along the  $z$  axis. Maxwell field equations and equations of hydrodynamics are used to arrive at the law for the dispersion of surface waves, in addition to boundary conditions with  $y = 0$  and  $y \rightarrow \infty$ . The dependence of all variables on coordinates and time is represented as  $\exp i(k_1 r_1 - \omega t)$ , with  $k_1$  representing the wave vector component and  $\omega$  the frequency. Equations are given for the two partial waves existing in a semiconductor and for the relationship between the tangential components of the electric field at the  $y = 0$  boundary, which equal zero, and each partial wave. The dispersion equation is then written for surface waves at the semiconductor-metal boundary. The conditions under which surface waves exist are arrived at and it is shown that they can be propagated independently in relation to the external magnetic field. Equations are derived for oblique surface waves. One of these equations describes the law of dispersion of surface waves of the helicon type. It is demonstrated that low-frequency electromagnetic surface waves propagated along  $H_0$  do not exist; waves of this type at a semiconductor-metal boundary can be propagated only across  $H_0$ . References 7: 4 Russian, 3 Western. [43-8831]

## PHOTOINDUCED ACOUSTOMAGNETOELECTRIC EFFECT IN A LONGITUDINAL MAGNETIC FIELD

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[Abstract] On the basis of previous studies (1974) on the influence of intense laser emission on the acoustomagnetolectric (AME) effect in monopolar semiconductors, the possibility is discussed of increasing the region of the existence of the AME effect by means of laser exposure, namely the AME effect in a longitudinal magnetic field. Here longitudinal means parallel to the direction of the acoustic stream. This effect is caused by the anisotropy induced by polarized irradiation in an isotropic medium and is analogous to the photoinduced Hall effect in a longitudinal magnetic field. The particular case of a weak magnetic field and a completely degenerated electron gas is discussed. It is assumed that the length of the sonic wave is small as compared with the length of the electron's mean free path and the Larmor radius. The emission quantum energy is assumed to be high as compared with the Fermi energy and the value of  $\hbar^2 q^2 / 2m$ , where  $q$  is the wave number of the acoustic phonon. An equation is given for the acoustoelectric current and the total current consisting of the acoustoelectric current and the ohmic current. It is assumed that the magnetic field and acoustic stream are directed along the  $x$  axis and the electric radiation field lies in plane  $xz$ . From the equations presented the component of the constant electric field along the  $y$  axis is derived. This component represents the AME field caused by the combined effect of the acoustic stream, the magnetic field and the emission. The AME field depends considerably on the scattering mechanism and reaches its highest value in the case of impurity scattering. References 8: 7 Russian, 1 Western.  
[43-8831]

## INFLUENCE OF ELECTRON SCATTERING MECHANISMS ON THE ACOUSTOMAGNETOELECTRIC EFFECT

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[Abstract] It was demonstrated in an earlier study (1976) that with low-temperature scattering in optical phonons, in spite of the fact that the relaxation time of electrons does not depend on the energy under these conditions, the magnitude of the acoustomagnetolectric (AME) field can be considerably greater than with quasi-elastic scattering mechanisms. A discussion is presented here of the AME effect with the presence of both quasi-elastic scattering mechanisms and of nonelastic scattering in

optical phonons. A study was made of the dependence of an AME field on the relationship between the elastic and nonelastic mechanisms. It has been demonstrated that the contribution of nonelastic processes can both decrease and increase, depending on the strength of the magnetic field, with an increase in the ratio of the relaxation times of the elastic and nonelastic mechanisms. It is assumed that the semiconductor is monopolar, nondegenerate and isotropic with a square dispersion law. It is further assumed that the length of the sonic wave is slight as compared with the length of the electron's mean free path, the shielding distance and the Larmor radius and that the magnetic field is nonquantizing. An equation is derived for the AME field with the existence of both scattering mechanisms. The cases of strong and weak magnetic fields are discussed individually. Equations are derived which demonstrate that in the case of strong magnetic fields the ratio of  $E_x/E_x^0$  increases linearly, and in the case of weak magnetic fields decreases, with an increase in  $\tau_0/\tau_{10}$ , where  $E_x^0$  represents the AME field with the existence of only quasi-elastic electron scattering mechanisms,  $\tau$  represents the relaxation time and  $\tau_{10}$  equals  $\tau_0 \exp(\hbar\omega_0/kT)$ . It is assumed that the acoustic stream,  $W$ , is propagated along the  $x$  axis and the magnetic field,  $H$ , is applied in the direction of the  $z$  axis. It is concluded that the contribution of nonelastic scattering in optical phonons to the AME field can become quite considerable and even decisive under specific conditions. The author thanks E. M. Epshteyn for formulation of the problem and discussion of the results. Figures 1; references 9: 8 Russian, 1 Western. [43-8831]

UDC 621.382.2

#### VOLT-AMPERE CHARACTERISTICS OF S-DIODES BASED ON GALLIUM ARSENIDE WITH A CHROMIUM IMPURITY AND NEGATIVE RESISTANCE WITH BACK BIAS

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[Abstract] The results are given of a study of the forward and reverse sides of the volt-ampere characteristics and switching time of diodes based on  $p^+-v-n$  structures whose  $v$  region is produced in the process of the diffusion of chromium in  $n$ -GaAs. The  $p^+$  region is formed in the process of diffusion of a Pb - 5% Zn alloy and the  $n$  region is the starting GaAs with  $n = 2 \cdot 10^{16} \text{ cm}^{-3}$ . The thickness of the  $n$  region is 30 microns and the area of the  $p^+-v$  junction is about  $1 \cdot 10^{-3} \text{ cm}^2$ . The diodes used for the study were etched to the formation of a mesa structure. For the region of low current, measurements of the volt-ampere characteristics were made with an ammeter-voltmeter d.c. circuit and by means of a cathode-ray curve tracer utilizing 100-Hz direct current. The pulsed mode was used for measurements in the high-current region. All measurements were made at room temperature. It is demonstrated



that the distinguishing characteristic of the volt-ampere characteristics of the diodes studied is the presence on the reverse side of a current-controlled negative resistance section. The time for switching a diode from the high-resistance to the low-resistance state is less than  $10^{-9}$  s and practically does not depend on the level of the current to which the diode is switched over the current range of approximately  $10^{-6}$  to 5 A. Switching takes place with a time delay after supplying the voltage pulse varying from single numbers of seconds at voltages approximately equal to the switching voltage to single numbers of nanoseconds at voltages approximately equal to twice the switching voltage. With a switching current of  $10^{-6}$  to  $10^{-7}$  A and a switching voltage of 300 to 600 V the residual voltage with currents of  $10^{-2}$  to 1 A equals 15 to 40 V. The sections which can be isolated on the reverse and forward sides of the volt-ampere characteristics of these diodes are described. The negative resistance section on the reverse side of the volt-ampere characteristic begins after a sudden increase in current and is formed under conditions of advanced avalanche breakdown. The latter conclusion is proven by the field strength in the space charge region and by the shape of the temperature-versus-switching-voltage curve. Processes taking place in the space charge region are responsible for the formation of negative resistance. At the present time there are insufficient published data for a detailed discussion of the mechanism of the formation of the negative resistance section on the reverse side of the volt-ampere characteristic. The authors thank L. V. Kaplinskiy for assistance during preparation of the diodes, and G. L. Prikhod'ko and D. D. Karimbayeva for bringing up the possibility of measuring the switching time of the diodes. Figures 2; references 13: 8 Russian, 5 Western.

[43-8831]

UDC 621.382.2

# VARIABLE SELECTIVE PHOTOCELLS BASED ON $\text{Ga}_{1-x}\text{Al}_x\text{As}(\text{Ge}, \text{Te})$ p-n STRUCTURES

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[Abstract] An experimental demonstration is given of the fact that the use of doping impurities which make possible a greater gradient of the absorption edge of semiconductors makes it possible to reduce the half-width of the quantum photosensitivity spectrum of p-n structures and to create highly efficient selective photocells. The results are given of a study of selective photocells created on the basis of variable-band  $\text{Ga}_{1-x}\text{Al}_x\text{As}(\text{Ge}, \text{Te})$  p-n structures the width of whose forbidden band and whose crossover transition threshold energy increase from the substrate to the illuminated surface, and in which the plane of the p-n junction is perpendicular to the direction



of the change in width of the forbidden band. Variband p-n structures were fabricated by liquid epitaxy, the substrates being crystals of n-GaAs doped with Te to an electron concentration of  $(2 \text{ to } 3) \cdot 10^{17} \text{ cm}^{-3}$  and oriented along crystallographic plane (100). The molten solution was supersaturated by repeatedly enriching it with aluminum and by forced cooling. A smooth p-n junction was formed in the process of crystallization of the variband film by overcompensation of Te in the initial molten solution by mixing with one of the admixed melts doped with Ge. Variband structures were produced in which the mole fraction of AlAs in the region of the p-n junction was within the range of 0.4 to 0.7 for different structures. From these structures photocells were fabricated with an illuminated p-region with an area of the illuminated surface of 1 to 1.5 mm<sup>2</sup>. Photosensitivity spectra and current-vs.-voltage characteristics in darkness and in exposure to photons with an energy equal to the maximum energy in the photosensitivity spectra were measured in the photocells. A calibrated germanium photocell was used to measure the current density of the radiation. All measurements were conducted at room temperature. Spectra are shown of the quantum photosensitivity of two variband photocells of this type with various gradients of the energy of crossover transitions,  $VE_0$ . Structures with a higher value of  $VE_0$  have a greater half-width of the quantum photosensitivity spectrum. With  $VE_0 = 300 \text{ eV/cm}$  the maximum quantum photosensitivity,  $Q_m$ , equals 0.6 to 0.7 electrons per photon, and the half-width of the spectrum,  $\delta$ , equals 80 to 100 meV. For variband structures of this type the minimally achievable  $\delta$  equals 40 meV at room temperature. Figures 3; references: 3 Russian. [43-8831]

UDC 621.382.2

# STUDY OF THE ELECTRICAL CHARACTERISTICS OF AN IMPATT DIODE WITH A HETEROJUNCTION

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KONAKOVA, R. V. and TKHORIK, Yu. A.

[Abstract] A description and the results are given of a study of the correlation between the properties of the interface and the reverse side of the volt-ampere characteristic of an IMPATT diode and of the relationship between the structural ideality of the interface and the microwave parameters of an IMPATT diode. The experiments conducted indicate that there is a correlation between the structural and recombination properties of the interface and the mechanism for the transmission of current in back-biased heterojunctions and that furthermore it is possible to improve the static and dynamic parameters of IMPATT diodes by reducing defects in the interface. Investigations were made of  $p\text{Ge}-nn^+\text{GaAs}$  and  $p(\text{Si}_x\text{Ge}_{1-x})-nn^+\text{GaAs}$ , where  $x \approx 0.02$ , IMPATT diodes with heterojunctions and  $\text{Pt}-nn^+\text{GaAs}$  Schottky diodes fabricated on the same  $nn^+\text{GaAs}$  substrates, and of  $\text{Pt}-n^+nn^{++}\text{GaAs}$  Schottky diodes. The heterojunctions were produced by the thermal spraying of germanium or by the method of solid solutions under vacuum. The germanium and solid solution films were about one micron

thick and the concentration of free holes at the interface in both cases equaled  $10^{18} \text{ cm}^{-3}$ . Schottky barriers were produced by the thermal spraying of platinum under vacuum and the thickness of the sprayed film was about 1000 Å. The concentration of free electrons in the n film of gallium arsenide equaled  $8 \cdot 10^{15} \text{ cm}^{-3}$  and the thickness of this film was six microns; the concentration of free electrons in  $n^+$  gallium arsenide was not greater than  $2 \cdot 10^{18} \text{ cm}^{-3}$  and the thickness of the film was 250 microns. In  $n^+n^{++}$  structures the concentration of free electrons in the film equaled  $4 \cdot 10^{16}$ ,  $8 \cdot 10^{15}$  and  $2 \cdot 10^{16} \text{ cm}^{-3}$  and the thickness of the films was respectively 0.1, 6 and 250 microns. The diodes were fabricated as reverse mesa structures with an electrochemically grown heat sink. Structural defects were studied by metallographic methods, static volt-ampere characteristics were studied over a broad temperature range, and at 300° K measurements were made of volt-farad characteristics at a frequency of 1 MHz, as well as of field dependences of the short-circuit photocurrent in the region of the internal absorption of gallium arsenide, at a wavelength of about 0.88 micron, for the purpose of determining the diffusion length of minority charge carriers. Measurements were made of the dependence of an IMPATT diode's output power on the bias current. The data of a metallographic analysis of the heterojunctions studied as well as the results of measuring the diffusion length of minority charge carriers near the interface make it possible to conclude that employing a solid solution with a lattice constant close to the lattice parameter of gallium arsenide reduces the tunnel-recombination component of the back current in the prebreakdown region, resulting from a reduction in the density of structural defects at the interface of the heterojunction. When a defect region is present in the prebreakdown section of the volt-ampere characteristic, the tunnel-recombination component of the current predominates, resulting in a substantial reduction of generation efficiency. Figures 2; tables 1; references 15: 10 Russian, 5 Western (1 in translation).

[44-8831]

UDC 621.383.52

#### PHOTOCONDUCTIVITY OF p-i-n STRUCTURES WITH THE ABSORPTION OF LIGHT IN INJECTED CARRIERS

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BLOKHIN, I. K., OSIPOV, V. V., STAFEYEV, V. I. and KHOLODNOV, V. A.

[Abstract] A study is made of the photoelectric effect in p-i-n diodes with not too long a base, caused by the absorption of light in free carriers injected into a high-resistance base of the structure from its n and p regions. It is assumed that in the absence of overcharging of recombination centers the lifetime of electrons is longer than that of holes. This is a situation realized in many diodes based on compensated semiconductors. The nature of the distribution of unbalanced

carriers in the base of the diode substantially depends on the thickness of the base and the level of injection, i.e., the amount of current flowing through the specimen. Under specific conditions the distribution of injected carriers in the base of the diode is mainly determined by their diffusion with both a low and a high level of injection. An expression is derived for the volt-ampere characteristic of not very long diodes of this type based on compensated semiconductors over a specific current density range. Expressions are derived for the change in the effective temperature of electrons and holes with slight warming of carriers by means of light; it is assumed that only electrons are effectively heated, in order to avoid unwieldy expressions. The results arrived at are not fundamentally changed by simultaneously taking into account the heating of electrons and holes. The current and voltage photosensitivity of the diodes discussed are calculated for the case of mild illumination. It is demonstrated that it is possible to represent not too long diodes as photoconductive cells which are controlled by means of injection from their contacts. A comparison is made between the sensitivity of the structures discussed here and that of photoconductive cells having identical geometrical dimensions as the base of the diode and made of a similar material in which the concentration of balanced electrons equals the concentration of injected electrons in the diode's base averaged for the base. Under these conditions the absorption of light in the diode and photoconductive cell is identical. It is demonstrated that under conditions of injection amplification of both the photocurrent passing through the diode and of the photovoltage in the load resistance takes place. References 14: 12 Russian, 2 Western (1 in translation).  
[44-8831]

## RELATIVE DISTRIBUTIONS OF TURBULENT FLUCTUATIONS OF INTENSITY OF LIGHT AT SPACED WAVELENGTHS

Gor'kiy IZV. VUZ: RADIOFIZIKA in Russian Vol 23, No 8, 1980 pp 999-1001 manuscript received 10 Sep 79

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[Abstract] Experimental data are presented on the relative frequency distributions of fluctuations of the intensity of light observed at a single point for combined broad light beams with wavelengths of 0.44 and 0.63 micron in a turbulent atmosphere. The relative distribution,  $W_{1,2}(\omega)$ , is shown to represent a correlation of fluctuations in the intensity of two signals passing through identical narrow-band filters with a mid-band frequency of  $\omega$ . The goal of the experiment was to study the conditions for the random focusing of radiation. Serving as light sources were He-Cd and He-Ne lasers whose light beams were combined by means of a system of mirrors with a dielectric coating and were expanded by means of a single mirror-and-lens collimator with an exit diameter of 0.5 m. The experiment was conducted on a steppe along a route 1750 m long. The light beams traveled at an altitude of 1 to 2 m from the surface of the earth. The structural characteristic of the field of turbulent fluctuations in the dielectric constant was determined from optical measurements using as a reference the blurring of the image in the focal plane of a telescope at a wavelength of 0.63 micron. For the purpose of measuring fluctuations in intensity, the light passing through the 0.5-mm receiving diaphragm was split into two beams and was fed through interference filters admitting radiation with a wavelength of 0.44 and 0.63 micron to two multiplier phototubes. Signals from these phototubes were recorded on magnetic tape and then entered into a computer. Computations of relative and independent distributions were made on a computer by the rapid Fourier transform method. A study was made of the behavior of the distribution of coherence. The experimental data demonstrate that for low frequencies the coherence is lower than the value calculated in a first approximation by the method of smooth perturbations. An unexpected result is the fact that at high frequencies the coherence is greater than this approximation produces and increases noticeably with an increase in the parameter characterizing measuring conditions,  $\beta_2^0 = 0.31 C_e^2 k_0^{7/6} L^{11/6}$ , where  $C_e^2$  is the structural characteristic of the field of turbulent fluctuations in the dielectric constant,  $k = \pi(\lambda_1^{-1} + \lambda_2^{-1})$ , where  $\lambda$  is the wavelength, and  $L$  is the length of the route. Further detailed theoretical analysis of this unexpected result is required. Experiments with a greater frequency difference or with higher values of  $\beta_0^2$  might prove useful. The author thanks V. A. Bezverkhnem and L. G. Pokasova for assistance in computer calculations. Figures 1; references 10: 8 Russian, 2 Western. [37-8831]



## STUDY OF THE PROCESS OF THE FORMATION OF A CATHODE SPOT IN THE SPARK BREAKDOWN OF HELIUM IN A STRONG LONGITUDINAL MAGNETIC FIELD

Gor'kiy IZV. VUZ: RADIOFIZIKA in Russian Vol 23, No 8, 1980 pp 992-995 manuscript received 11 Dec 79

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[Abstract] The results are given of an oscillographic investigation of the process of the formation of a cathode spot in the spark breakdown of helium with reference to the change in the duration of the voltage drop step in a strong longitudinal magnetic field. In a number of instances in spark breakdown the cathode spot does not form immediately after the streamer phase but after a certain period, which in an oscillographic study of breakdown is determined to be the duration of the step observed in the voltage drop. Investigations were conducted in a homogeneous electric field because it is one of the conditions for the origin of a voltage step. The experimental procedure is described in an earlier study (1974). Characteristic oscillograms are presented for the step-by-step change in voltage in the interelectrode gap at a pressure of 1900 mm Hg, with an interelectrode gap measuring 0.37 cm and with no overvoltages. Also shown are dependences of the duration of the voltage step on the pressure, interelectrode gap and magnetic field strength with an overvoltage of 16 percent and of the duration of the voltage step on the magnetic field strength with overvoltage of 16 percent, 30 percent and 50 percent with a pressure of 660 mm Hg and an interelectrode gap of 0.1 cm. It is demonstrated that the influence of a strong longitudinal magnetic field on the processes of the formation of a cathode spot depends substantially on the electric field strength, i.e., on the overvoltage in the gap. The magnetic field strength was 240 kOe maximum. It is demonstrated that the duration of the voltage step depends heavily on the pressure of the gas, the interelectrode gap, the breakdown voltage in the discharge gap and the strength of the magnetic field. With a reduction in pressure there is an increase in both the duration of the voltage step and in the degree of influence of a strong longitudinal magnetic field on its duration. One reason for the increase in the duration of the voltage step in the presence of a strong longitudinal magnetic field is the hampered entry of the cathode spot into the high-temperature quasi-stationary mode resulting from restriction of the migration of microcathode spots over the surface of the electrode. Figures 3; references 11: 8 Russian, 3 Western. [37-8831]

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